Singing in the Shower to Shaking in Your Boots: The science of emotion

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THE Longwood SEMINARS AT HARVARD MEDICAL SCHOOL

HARVARD MEDICAL SCHOOL

Singing in the Shower to Shaking in Your Boots:
The science of emotion

Speaking about happiness

George Vaillant, MD
Professor of Psychiatry,
Harvard Medical School
Massachusetts General Hospital

Speaking about fear

Mohammed Milad, PhD
Associate Professor of Psychiatry,
Harvard Medical School
Massachusetts General Hospital

Speaking about love

Richard Schwartz, MD
Associate Clinical Professor of Psychiatry,
Harvard Medical School
McLean Hospital

Jacqueline Olds, MD
Associate Clinical Professor of Psychiatry,
Harvard Medical School
Massachusetts General Hospital

About the Speakers

George Vaillant, MD

Dr. Vaillant is a Professor of Psychiatry at Harvard Medical School and the Department of Psychiatry, Massachusetts General Hospital. Dr. Vaillant has spent his research career charting adult development and the recovery process of schizophrenia, heroin addiction, alcoholism, and personality disorder. He has spent the last 35 years as Director of the Study of Adult Development at the Harvard University Health Service. The study has prospectively charted the lives of 824 men and women for almost 70 years. His published works include *Adaptation to Life, 1977*, *The Wisdom of The Ego, 1993, The Natural History of Alcoholism-Revisited, 1995,* and *Aging Well*, 2002*.* His most recent book on the positive emotions, *Spiritual Evolution* was published by Doubleday Broadway in 2008.

A graduate of Harvard College and Harvard Medical School, Dr. Vaillant did his residency at the Massachusetts Mental Health Center and completed his psychoanalytic training at the Boston Psychoanalytic Institute. He has been a Fellow at the Center for the Advanced Study in the Behavioral Sciences, is a Fellow of the American College of Psychiatrists and has been an invited speaker and consultant for seminars and workshops throughout the world. A major focus of his work in the past has been individual adult development; more recently he has been interested in positive emotions and their relationship to community development. He is a past Class A trustee of Alcoholics Anonymous and is currently on the Steering Committee of Positive Psychology.

Dr. Vaillant has received the Foundations Fund Prize for Research in Psychiatry from the American Psychiatric Association, the Strecker Award from The Institute of Pennsylvania Hospital, and the Jellinek Award for research in alcoholism. Most recently he received The Distinguished Service Award from the American Psychiatric Association.

Mohammed Milad, PhD

Dr. Mohammed R. Milad is currently an Associate Professor of Psychiatry at Harvard Medical School and Director of the Behavioral Neuroscience Lab at MGH. Dr. Milad received a number of awards including the Positive Neuroscience Award from the Templeton Foundation and was named Kavli Fellow, Frontier of Science by the National Academy of Sciences. Currently, Dr. Milad employs a multimodal approach using PET, fMRI, and psychophysiology in humans and neuropharmacology and molecular tools in rodents to examine the neural correlates of fear extinction. Some of the research questions/areas he is interested in include examining the functional integrity of the fear extinction network across psychiatric disorders and examining the influence of sex hormones on fear extinction.

Richard Schwartz, MD and Jacqueline Olds, MD

Dr. Jacqueline Olds and Dr. Richard S. Schwartz are both Associate Clinical Professors of Psychiatry at Harvard Medical School. Dr. Olds teaches child psychiatry and Dr. Schwartz teaches adult psychiatry at the McLean and Massachusetts General Hospitals. They are both psychoanalysts, on the faculty of the Boston Psychoanalytic Institute and Society and the Psychoanalytic Couples and Family Institute of New England. Their most recent book, *The Lonely American*, was named an Outstanding Academic Title of the year by The American Library Association/Choice Magazine. They have written two other books, *Overcoming Loneliness in Everyday Life* and *Marriage in Motion*. Married to each other and with two grown children, they each maintain a private practice in Cambridge, MA.

Four sob stories: The effects of tears and three other tales of woe

We expect babies and children to cry, but House Speaker John Boehner's well-chronicled weepiness is a reminder that adults (including menfolk) shed plenty of tears, too. Grief, personal conflict, and feelings of inadequacy are among the main reasons, but grown-ups also fill buckets at weddings, graduations, and reunions because they are *so* happy. Having a good cry every now and then may not be a bad idea. But crying too easily — or for no apparent reason — can be a symptom of brain damage from a neurological condition like amyotrophic lateral sclerosis (Lou Gehrig's disease) or multiple strokes.

Crying is a big topic, but here's a quick rundown on four areas of investigation.

1. Crying and tears

Other animals whimper in distress, but humans are believed to be the only species wired so that strong emotions provoke the shedding of tears. Dr. William H. Frey II, an Alzheimer's researcher in St. Paul, Minn., who has studied tears as a sideline, reported in the early 1980s that tears provoked by emotion contain higher levels of proteins and the mineral manganese than the normal teary fluid that protects and lubricates our eyes.

In 2011, Israeli researchers reported results in the journal *Science* that suggested tears are capable of sending chemical signals. They conducted an experiment that involved having men sniff women's tears (collected from women who watched sad movies) and a saline solution. They couldn't distinguish between them by smell, but other tests showed that the men reacted differently to a whiff of the real tears. Their testosterone levels dipped, and brain scans showed less activity in areas associated with sexual arousal. The researchers' theory: women's tears may counteract men's aggressive tendencies.

Others, including Darwin himself, have speculated on the role of tears in evolution and natural selection. Tears, it has been said, are a clear signal of vulnerability, so they may have helped create emotional bonds that kept human communities together and therefore conferred some reproductive advantages.

2. Crying to feel better

Strong emotions bring on crying, but crying also often seems to release built-up stress and tension. The notion that crying may have a beneficial cathartic effect goes back to the Greeks and Romans, and Freud wrote about a large part of an emotion disappearing if it's expressed. Numerous surveys and questionnaire-based studies show people believe they feel better after crying — and not just in this country. Half of the respondents in a large international study (4,200 young adults from 30 countries) reported that they felt better mentally after crying, compared with how they felt beforehand. About 40% felt the same, and the remaining 10% felt worse.

However, when researchers have studied crying in a laboratory setting, using sad movies to elicit tears (they call them tearjerkers for a reason), they've found just the opposite: criers feel worse, not better, than

noncriers exposed to the same stimulus. There are any number of explanations for the inconsistency. People may feel bad right after crying, when lab measurements are made, but better about the episode as time goes on, particularly if beliefs about the benefits of “having a good cry” are widely held. Moreover, crying over a sad movie may cause or accentuate feelings of helplessness — there’s nothing we can do to help the characters in the movie — whereas crying in reaction to other stimuli may encourage insight or resolve feelings.

But perhaps the best and most obvious explanation for the discrepancy is that crying outside a lab setting is often done in a social context, and if other people respond with comforting words and gestures, we end up with some psychological reward for our tears. Indeed, in the international survey, about 40% of the respondents were comforted when they cried, and, just as one might expect, that response was associated with a feel-good cry. Of course, the reaction isn’t always positive. And crying can bring on shame. Many people hold back their tears until they’re alone. In the international survey, 35% of the respondents reported crying alone and 31% with one other person present.

Researchers have studied whether there might be an underlying physiological reaction that explains the “good cry.” Some studies have shown that crying is associated with arousal and revving up of the part of the nervous system responsible for the flight-or-fight response. But there seems to be a bit more evidence that weeping is associated with activation of the parasympathetic nervous system, which slows the heartbeat and winds us down, not up. Several years ago, Dutch researchers reported that the heart rates of 60 study subjects increased as they watched cry-eliciting movies, but then subsided after they started to cry. It seems that there’s a handoff from fight-or-flight arousal to parasympathetic calming, which is certainly how many of us experience crying.

3. Crying and depression

Depression makes people sad, so it’s presumed that depressed people cry more than those who aren’t depressed. There’s also an abiding belief that more severe bouts with depression can have just the opposite effect and rob people of their capacity to cry. Neither proposition seems farfetched, but researchers who have scoured the published studies say there’s actually little evidence to support them.

A small study conducted several years ago to begin filling the void suggests, though, that the conventional wisdom may not be too far off the mark (although it is just one small study). The 44 study subjects with mood disorders (dysthymia, adjustment disorder with depressed mood, major depressive disorder) were, in fact, more prone to crying than 132 people in a comparison group. At the same time, the researchers found that an inability to cry was associated with severe depression.

Many of the standardized questionnaires used to measure depression have questions about crying. Some researchers have raised the interesting question whether relying on crying as a sign of depression results in an underestimation of depression among men, who don’t, John Boehner notwithstanding, cry as often as women. Rather than weep, depressed men may become aggressive and irritable. Yet, at least in this one small study, the gender imbalance seemed to even out, and men and women with mood disorders were equally prone to crying.

4. Crying and medical training

Medical training can be an emotionally potent mixture of daunting intellectual challenges and the first experiences with patient suffering and death.

Several years ago, researchers surveyed third-year medical students and first-year residents at two medical schools about crying related to their training. Almost three-quarters (71%) had cried at least once in the past year and about half had cried multiple times. The most common reason for shedding tears was feeling overworked or burned out. Women were twice as likely to have wept than men (93% vs. 44%). Most of the weeping was done in private.

No one wants doctors trained so they're bawling all the time, but the researchers said crying and expression of emotions can be a valuable way of communicating and letting out stress.

To learn more…
This information is prepared by the editors of the Harvard Health Publications division of Harvard Medical School. It originally appeared in the April 2011 issue of the *Harvard Health Letter* available from http://www.health.harvard.edu/newsletters/health.

Mindfulness meditation changes the brain

Mindfulness meditation alters regions of the brain associated with memory, awareness of self, and compassion, according to a brain imaging study by researchers at Massachusetts General Hospital in Boston and the University of Massachusetts Medical School in Worcester. Other studies have found differences in the brains of experienced meditators compared with non-meditators, but this is the first investigation to document brain changes occurring over time in people learning how to meditate mindfully. Results were published in *Psychiatry Research: Neuroimaging* (Jan. 30, 2011).

Mindfulness meditation is the practice of paying attention to what you're experiencing from moment to moment without drifting into thoughts about the past or concerns about the future and without analyzing (or making judgments about) what is going on around you. It's not a new idea. Religious texts have extolled mindfulness for centuries, and it's central to Buddhism and other contemplative traditions.

Since the early 1980s, mindfulness meditation has increasingly found a place in mainstream health care and medicine because of evidence that it's good for emotional and physical health — for example, helping to reduce anxiety, stress, depression, chronic pain, psoriasis, headache, high blood pressure, and high cholesterol. Some studies suggest that it can improve immune function. And research has found an association between mindfulness meditation–induced improvements in psychological well-being and increased activity of telomerase, an enzyme important to the long-term health of cells. With advances in neuroimaging, scientists have begun to explore the brain mechanisms that may underlie these benefits.

The study. Researchers recruited 16 participants from the eight-week Mindfulness-Based Stress Reduction program at the University of Massachusetts Medical School's Center for Mindfulness. The participants attended weekly 2.5-hour group meetings in which they practiced mindfulness meditation and were given audio recordings of guided meditation exercises and told to practice daily at home. Before the start of the program and after its completion, researchers took MRI images of the meditators' brains as well as the brains of 17 non-meditators, who served as a control group.

The results. On average, the meditators spent about one half-hour a day meditating during the eight-week course. Questionnaire responses indicated that at the end of the eight weeks, they felt more capable of acting with awareness, observing, and remaining nonjudgmental. The MRI images showed that the meditators (but not the controls) had increased concentrations of gray matter (the "computing" or processing neurons) in several brain areas, including the hippocampus (a deep brain structure important for learning, memory, and the regulation of emotions) and other regions associated with remembering the past and imagining the future, as well as with introspection, empathy, and the ability to acknowledge the viewpoints of others. The authors suggested that these changes may be beneficial because of their impact on the synthesis of neurotransmitters (particularly serotonin and norepinephrine) that influence mood. In an earlier study of the same participants, the researchers had found that meditation practice reduced the concentration of gray matter in the amygdala, a region associated with fear, anxiety, and stress — and that this reduction was correlated with lower stress levels.

Limitations and implications. Although this study was well designed, it's not likely to be the last word on the subject. It was small, and the significance of changes in grey matter concentration isn't entirely clear. Also, brain changes were not correlated with the amount of time a meditator spent practicing, so other factors may play a role. Nonetheless, these findings suggest directions for research. We already know that learning new physical skills (such as juggling) can change the brain; this study offers intriguing new evidence that learning to think in a new way can do the same.

To learn more…
This information is prepared by the editors of the Harvard Health Publications division of Harvard Medical School. It originally appeared in the April 2011 issue of the *Harvard Women's Health Watch* available from http://www.health.harvard.edu/newsletters/womens.

Expressive writing for mental health

Stress, trauma, and unexpected life developments — such as a cancer diagnosis, a car accident, or a layoff — can throw people off stride emotionally and mentally. The natural response is to wonder why something bad happened and what to do next. In some people, this can lead to rumination — dwelling on the event — and possibly to a mental health problem, such as depression or post-traumatic stress disorder (PTSD).

Expressive writing — a technique that involves writing about thoughts and feelings that arise from a traumatic or stressful life experience — may help some people cope with the emotional fallout of such events. But it's not a cure-all, and it won't work for everyone. Expressive writing appears to be more effective for healthy people who have sustained an emotional blow than it is for people struggling with ongoing or severe mental health challenges, such as major depression or PTSD.

A flexible approach

Dr. James W. Pennebaker, currently chair of the psychology department at the University of Texas, Austin, has conducted much of the research on the health benefits of expressive writing. In one early study, Dr. Pennebaker asked 46 healthy college students to write about either personally traumatic life events or trivial

topics for 15 minutes on four consecutive days. For six months following the experiment, students who wrote about traumatic events visited the campus health center less often, and used a pain reliever less frequently, than those who wrote about inconsequential matters.

In the years since then, expressive writing has evolved and its use expanded. Studies have involved all sorts of permutations: for example, participants writing for 10 to 30 minutes at a time, for one to five days — or weekly for four weeks. The standard format involves writing for a specified period each day about a particularly stressful or traumatic experience. Participants usually write nonstop while exploring their innermost thoughts and feelings without inhibition (and the writing samples remain confidential for that reason). They may also use the exercise to understand how the traumatic event may revive memories of other stressful events.

Most studies have evaluated the impact of expressive writing on people with physical health conditions such as sleep apnea, asthma, migraine headaches, rheumatoid arthritis, HIV, and cancer. Likewise, most of the outcomes measured are physical, and the findings — such as blood pressure and heart rate — suggest that expressive writing initially may upset people but eventually helps them to relax.

More recently, researchers have evaluated whether expressive writing helps reduce stress and anxiety. One study found that this technique reduced stigma-related stress in gay men. Another found that it benefited chronically stressed caregivers of older adults. And a study by researchers at the University of Chicago found that anxious test takers who wrote briefly about their thoughts and feelings before taking an important exam earned better grades than those who did not.

Why writing may help

When Dr. Pennebaker and other researchers first started studying expressive writing, the prevailing theory was that it might help people overcome emotional inhibition. According to this theory, people who had suppressed a traumatic memory might learn to move beyond the experience once they expressed their emotions about it. But it's not quite that simple. Instead, multiple mechanisms may underlie the benefits of expressive writing.

The act of thinking about an experience, as well as expressing emotions, seems to be important. In this way, writing helps people to organize thoughts and give meaning to a traumatic experience. Or the process of writing may enable them to learn to better regulate their emotions. It's also possible that writing about something fosters an intellectual process — the act of constructing a story about a traumatic event — that helps someone break free of the endless mental cycling more typical of brooding or rumination. Finally, when people open up privately about a traumatic event, they are more likely to talk with others about it — suggesting that writing leads indirectly to reaching out for social support that can aid healing.

Timing also matters. A few studies have found that people who write about a traumatic event immediately after it occurs may actually feel worse after expressive writing, possibly because they are not yet ready to face it. As such, Dr. Pennebaker advises clinicians and patients to wait at least one or two months after a traumatic event before trying this technique.

Even with these caveats, however, expressive writing is such an easy, low-cost technique — much like taking a good brisk walk — that it may be worth trying to see if it helps.

To learn more…
This information is prepared by the editors of the Harvard Health Publications division of Harvard Medical School. You can learn more about the mental health topics of anxiety and phobia in the special health report, *Coping with Anxiety and Phobias.* You can read an excerpt at: http://www.health.harvard.edu/special_health_reports/AP.

Harness positive psychology

When psychology was in its infancy, its aims encompassed a desire to understand what helps people flourish. Over time that goal gave way to a narrower focus on deciphering and repairing mental illnesses. This frustrated some mental health professionals, who chose a different tack in their work. "Treatment is not just fixing what is broken, it is nurturing what is best," Martin E.P. Seligman and Mihaly Csikszentmihalyi, two leaders in the burgeoning field of positive psychology, wrote when looking back on why this movement gained traction. In this spirit, this section will help you find ways to flourish.

The goal for harnessing positive psychology

Positive psychology seeks to help people thrive and stretch, to recognize and build upon deep-seated strengths, to identify and actively create happiness. Excelling here doesn't depend on your paycheck, the car you drive, or the size of your home. With these thoughts in mind, the goal is to encourage you to appreciate your life, invest it with greater meaning, and reap more joy.

Why bother to ease stress?

Positive psychology tucks under one umbrella the study of positive emotions, full engagement in activities, personal virtues and strengths, and paths to fulfillment and a meaningful life. That's quite a disparate grab bag, and by dipping into it you may well locate deeper satisfaction, fun, and greater abundance in your life.

Experts in the field of positive psychology consider questions of happiness, vitality, and meaning worthy of serious scientific research — as well they should, since these issues affect our quality of life and well-being. A sunny, unflappable disposition is a plus, but it's not the price of an entry ticket to all that's good in life. Indeed, a growing body of research is finding that it's possible to nurture qualities like optimism even in people who lean toward pessimism, heighten fleeting feelings of happiness by savoring them, and find joy through expressing gratitude and helping others. By doing so, some studies suggest you stand to gain a longer life and better health by some measures, such as lower risks for hypertension and diabetes.

Six choices for harnessing positive psychology

Our six choices aim to add joy, deeper meaning, and greater connection with others to your days. Some will seem easy, others harder. Start by selecting one that seems like a sure bet. You're more likely to be successful if you begin by choosing a **SMART GOAL**. Successfully incorporate it into your life before moving

on to another challenge. If all the choices seem too difficult, flip back to “Breaking it down” and think about how you might make headway with tinier steps.

Smile at the first 10 people of the day (Easy)

Why? Smiling is contagious and feelings may mirror the face. When Swedish researchers monitored facial muscles on study participants shown images of faces expressing different emotions, they observed that a smiling face triggered muscles employed when smiling and a frowning face begat flickers in muscles engaged when frowning. A smile — at least a genuine one — telegraphs inner happiness to everyone around you. A number of researchers have asked if the reverse is true, too: could your facial expressions influence your emotions? Some research indicates that it does: simply smiling or frowning elicits feelings of happiness or distress. And deliberately inhibiting facial expressions appeared to tone down emotions triggered by negative and neutral (though not positive) video clips, according to a separate study published in *The Journal of Research in Personality* in 2009.

What to do: Smile for the first 10 people you see. You’re likely to find they’ll smile back. Plus the positive feedback loop might make your morning happier, too. Try this for a week. Observe how you feel when smiling — maybe silly, maybe a bit forced, maybe genuinely happy — and during the rest of your day.

Give thanks (Easy)

Gratitude is strongly and consistently associated with greater happiness in positive psychology research. All of us have much to be thankful for — a sunny day, a loving partner, a full belly, a joyful moment shared with a friend, or even light traffic on the way to work. Shining a spotlight on goodness in your life allows you to truly relish positive experiences. As you do, you may recognize that the wellspring of this goodness lies beyond you. Such feelings connect us to something larger than our individual experiences — whether to other people, nature, or a higher power.

What to do: Every day, set aside a few moments to write down three things for which you feel thankful. *It was a beautiful day today. We had a chance to have dinner together as a family. I finally called my sister and had a good talk.* Be specific and relive the sensations you felt as you remember what each of the gifts means to you. If it seems more natural, say it aloud to yourself or a loved one, or turn it into a prayer.

Seek out happy people (Medium)

After crunching social network data derived from more than 4,700 adults in an arm of the Framingham Heart Study, researchers reported intriguing findings in *BMJ*. People surrounded by, and at the center of, many happy people are more likely to become happy in the future. Statistical models suggest this is more than birds of a feather flocking together. Rather, clusters of happiness appeared to spring from the spread of happiness. For example, having a friend who lived within a mile become happy boosted a person’s probability of happiness by 25%. Upbeat moods radiated as far as friends of friends of friends. And each additional friend counted as happy increased a person’s likelihood of being happy by about 9%.

What to do: Revel in the company of happy souls. In fact, it may be worth seeking happy people out through activities you enjoy, a religious community that resonates with you, and volunteer opportunities (see “Volunteer,” below), though the study doesn’t cover these situations. Snubbing less happy people isn’t necessary. As a *BMJ* commentator noted, unhappy acquaintances may make other contributions to our lives.

Volunteer (Medium)

Helping others kindles happiness, as many studies have demonstrated. When researchers at the London School of Economics examined the relationship between volunteering and measures of happiness in a large group of American adults, they found the more people volunteered, the happier they were, according to a 2008 study in Social Science and Medicine. Compared with people who never volunteered, the odds of being "very happy" rose 7% among those who volunteer monthly and 12% for people who volunteer every two to four weeks. Among weekly volunteers, 16% felt very happy — a hike in happiness comparable to having an income of $75,000–$100,000 versus $20,000, say the researchers. Giving time to religious organizations had the greatest impact.

What to do: Local volunteer opportunities abound, so spend time in a realm you enjoy. Try a senior center, park, school, religious organization, or political group you appreciate. Your workplace may organize volunteer projects — and may even offer a day of pay while you help out. Vacations that mix travel and volunteerism are another option. At disaster sites throughout the world, people with medical and building skills are especially welcome. The Internet has made volunteering easier. You can search for organizations you know and like, or nearby opportunities that could use an hour or day of your help, through Volunteer Match (www.volunteermatch.com), a national nonprofit organization dedicated to strengthening communities; the U.S. government site Serve.Gov (www.serve.gov); and Senior Corps (www.seniorcorps.gov), which puts the expertise and energies of Americans over 55 to good use. Another good source is AARP, which has launched a Web site called Create the Good (www.createthegood.org) to help you match interests and abilities to needs in your community. The site also has step-by-step videos and do-it-yourself tool kits for people who wish to head up or handle alone big or small volunteer efforts like conserving energy, organizing a river cleanup, helping someone get a handle on medications or find public benefits, starting a giving circle, and more.

Tally your strengths (Harder)

Signature strengths can be defined as character traits you identify with, appreciate, and enjoy using: you're a curious person, perhaps, and you have a lot of integrity. Christopher Peterson, scientific director of the VIA Institute on Character in Ohio, and Martin Seligman wrote a handbook describing six universally valued virtues, or core characteristics, and the underlying strengths through which people display them. They drew on philosophers and religions throughout history and across cultures to distill these virtues.

Strengths may change throughout life as circumstances do. Playing to strengths can help you meet challenges. For example, one person trying to influence a local school board to ban soft drink sales might tap into the strength to speak up forcefully and clearly at a meeting; another person strong in team-building might feel uncomfortable speaking out, yet could help build consensus among parents, nutritionists, and school officials. A study published in *American Psychologist* noted that happiness increased and depression decreased for six months in participants who were asked to identify their signature strengths and then use one in a new way every day for a week.

What to do: First assess your strengths (see next paragraph). Then choose just one to use in a new way every day for a week. For example, on day one you might plunge into an activity that makes you nervous (bravery), set a beautiful table for an ordinary meal (appreciation of beauty), or listen to a talk show you normally are at odds with and consider legitimate points it may raise (open-mindedness), depending on which of these strengths you've chosen. Strengths most closely linked to happiness — gratitude, hope, vitality, curiosity, and love — may be worth cultivating even if they're not on your current list of signature strengths.

Look over the accompanying table of six virtues and underlying strengths (see Table). If you have trouble identifying key strengths, think about what comes easily to you and what you often are complimented on. Or ask someone you respect and who knows you well to help. Or delve into this more fully by filling out the online Inventory of Signature Strengths Survey. You'll find it at www.health.harvard.edu/strengths. This 30-minute online questionnaire developed at the VIA Institute on Character identifies signature strengths. A free report provides a brief write-up of your five signature strengths. Paying a fee entitles you to a more comprehensive discussion of your strengths and virtues, plus suggested activities intended to bolster or expand on this foundation.

Table: Six virtues and underlying strengths

Virtue	Underlying strength
Wisdom: Intellectual strengths that help you gain and use information	• Creativity • Curiosity • Open-mindedness • Love of learning • Perspective
Courage: Strengths of will that help you accomplish goals in the face of fear and obstacles	• Integrity • Bravery • Persistence • Vitality
Humanity: Strengths that help you befriend others and tend relationships	• Social or emotional intelligence • Love • Kindness
Justice: Social or civic strengths that help bolster a healthy community	• Teamwork • Fairness • Leadership
Temperance: Protective traits that help you avoid excess and stay on track in the face of temptations	• Mercy • Humility and modesty • Self-control • Prudence

Transcendence: Strengths of meaning that connect you with the larger world and provide meaning	• Appreciation of beauty • Spirituality • Gratitude • Hope • Humor

Adapted from the VIA Institute on Character. For more information on virtues and signature strengths, go to www.viacharacter.org.

Find the flow (Harder)

Ever been so immersed in what you were doing that distractions and background chatter just fell away? Nothing existed except the shush of your skis on the snow, the sensation of your car sweeping around bends in the road, the images cast by the book you had your nose in, or the satisfying sense of pieces clicking into place as you worked though a challenging task. Dubbed "flow" by Mihaly Csikszentmihalyi, director of the Quality of Life Research Center at Claremont Graduate University, this state of being feels effortless, yet active. You lose awareness of time, you cease to think about yourself or feel distracted by extraneous thoughts. You may be working toward a goal — earning a graduate degree or winning a chess tournament — yet that isn't your primary motivation. Rather, you find the activity itself rewarding. Researchers have found flow hinges on a balance between the size of a challenge and the level of your skill. Watching TV, for example, isn't likely to spark a sense of flow even though you may find it relaxing.

What to do: Think about times in your life when you've experienced flow and seek a new way to invite it into your life. So if you feel confidence and pleasure in your driving, or have the ability to play a particular piano concerto, you might try driving your car on unfamiliar roads or playing a more complex composition. Match your skills to a new activity that offers rich sensory experiences: perhaps a pottery class, a carpentry project, or a different medium in art.

To learn more…
This information is prepared by the editors of the Harvard Health Publications division of Harvard Medical School, and excerpted from the special report, *Positive Psychology*. You can learn more about this publication at www.health.harvard.edu/PP.

HarvardMedicine

The following articles are selections from *Harvard Medicine* magazine's Summer 2011 issue.
Additional content can be found online, please visit: http://harvardmedicine.hms.harvard.edu/

The Contagion of Happiness:

Harvard researchers are discovering how we can all get happy

by Jessica Cerretani
Harvard Medicine Magazine, Summer 2011

Everyone, it seems—from Buddhist monks to positive psychologists, from Charles Schulz to the Beatles—has offered opinions on what it means to be happy. And whether you believe that bliss is found with a warm puppy or a warm gun, in a Prozac prescription or the pages of self–help books, you likely crave more of it. For all the bumper–sticker clichés and pop–culture platitudes, though, happiness is one of the less–studied human emotions. It's not a "treatable" problem like sadness, anger, or fear, and its very essence seems more the stuff of greeting cards than hard science. That's changing, however, as a growing number of researchers—including several affiliated with Harvard Medical School—are uncovering surprising facts about the nature of delight.


Nancy Etcoff
Al Carlay

THE SUNNY SIDE

One of the greatest challenges in the study of happiness lies in its definition. "Happiness is a big umbrella term that can mean different things to different people," says Nancy Etcoff, an HMS assistant professor of psychology in Massachusetts General Hospital's Department of Psychiatry. "We can view happiness in at least three ways—as a hedonic state, as a cognitive state, or as a general life philosophy. Happiness, then, can refer to a way of thinking, such as being optimistic; a way of feeling joy, pleasure, relief, or gratitude; or simply a way of being."

Others make a clearer distinction between the concept of happiness and the positive emotions the word describes. "Happiness is just drive reduction," says George Vaillant '59, an HMS professor of psychiatry at Brigham and Women's Hospital who has studied the science of positive emotions. "Let's say you're speeding down the highway and your stomach is growling. You spot the Golden Arches, pull over, and order a Big Mac. That makes you 'happy.'" But that satisfaction is fleeting—the resultant heartburn likely lasts longer than your gratification.

Happiness, Vaillant believes, is a conscious state of mind, rooted in the neocortex, the region of the brain responsible for thinking, planning, and decision–making: You eat a hamburger and think, "I feel good."


George Vaillant
John Soares

Joy, on the other hand, is more complex. It's that warm, fuzzy feeling you get when you hear your child's laughter, embrace your sweetheart, or cuddle a puppy. "Joy is all about our connection to others," explains Vaillant. It's a subconscious, almost visceral feeling that appears to stem from the brain's limbic system, which is believed to control emotions, including pleasure. Unlike happiness, joy involves little cognitive awareness—you just feel good without thinking about it—but it's more enduring.

These intricacies have made joy difficult to measure, so scientists tend mainly to tackle what Vaillant calls the "tamer" idea of general happiness in their research. But that, too, has proved tricky. Medicine's penchant for problem–solving means that most researchers have focused their efforts on studying causes of and treatments for gloomier sentiments like sadness, depression, and anxiety. The smiley–faced cheer of happiness seems less serious—and less potentially profitable—in comparison.

THE PURSUIT OF HAPPINESS

Nevertheless, those who have plumbed the depths of our psyches for more details about how and why we experience positive emotions have uncovered some intriguing facts. Among their findings: Happiness is at least partially genetic. Researchers at the University of Minnesota have found that identical twins appear to share not only the same DNA, but the same general level of happiness, regardless of whether they were raised together or separately. Such studies suggest that nature may play a larger role than nurture in determining our "hedonic setpoint," or happiness thermostat.

Evolution is also responsible. "Human beings evolved in a dangerous world, where we had to recognize threats to survive," says Etcoff. "As a result, our brains are wired to be much more sensitive to negative emotions and sensations than positive ones."

Perhaps it's this predisposition to pessimism that makes many people wary of looking on the bright side. The exhilarating highs of happiness and joy, after all, increase our vulnerability to the depths of despair—a broken heart, a dashed hope, a shattering disappointment. "Positive emotions," Vaillant points out, "are often associated with tears."

Of course, if you're born with, say, Eeyore's setpoint, that doesn't mean you can't transform yourself into Tigger. While some of us appear biologically prone to shyness, depression, or anxiety, for example, we aren't predestined to a life of negativity. How we find happiness, it seems, may depend on where we look for it—and that isn't necessarily under the plastic

surgeon's knife or in a million–dollar mansion. Although a much–publicized 2011 report from the University of Texas at Austin found that the people ranked most attractive were about 10 percent happier than their less–attractive peers, other research suggests that our own beauty—or lack thereof—has little to do with a sunny disposition. In Etcoff's research for her book *Survival of the Prettiest*, she found that while attractive people tend to enjoy more advantages than plainer people, they don't necessarily experience greater life satisfaction.

Money doesn't always buy happiness, either. A boost in income does appear to trigger an elevation in mood, but only to a certain point—$75,000 a year to be exact, according to one recent study. People with lower incomes—particularly those at or below the poverty line—have more stress, but once financial worries ease, positive emotions plateau. If Bill Gates and Oprah Winfrey are happier than the rest of us, it isn't because of their bank accounts. In the end, a sense of gratitude for what we have may be what heartens us: Classic studies that compared the emotional well–being of lottery winners, paraplegics, and quadriplegics found all three groups had similar levels of current happiness, suggesting that once the initial windfall or trauma fades, we adapt to change and return to our original hedonic setpoint.

GLEE CLUB

So what *does* bring us happiness? Research shows that our relationships with others, rather than what we see in the mirror or find in our wallets, may be what matter most. It's a concept that held true for our cave–dwelling ancestors, who formed elaborate social structures to increase their odds of survival. These days, our connections are more about building a family, gossiping at the water cooler, and adding to our list of Facebook friends than outsmarting saber–toothed tigers. But results of the long–running Grant Study of Adult Development, which Vaillant helps oversee, suggest that the emotional benefits of connectedness remain. Vaillant and his colleagues have found, for instance, that only the capacity for loving relationships predicted life satisfaction in older men.

Nicholas Christakis

Kristyn Ulanday/Harvard News Office

In turn, being happy can have its own advantages. More than three decades ago, Grant Study data showed that good mental health in men slowed the deterioration of their physical health, even after adjusting for genetics, obesity, and tobacco and alcohol use. Although Vaillant has since found that after age 50 vascular risk factors such as smoking, elevated diastolic blood pressure, diabetes, obesity, and alcohol abuse appear to play a far greater role than mental health in subsequent health and longevity, other research still supports a link to mental health. Research by Ichiro Kawachi, an HMS associate

professor of medicine at Brigham and Women's Hospital, found a strong correlation between happiness and good health, both in individuals and within communities.

And there's more good news: Happiness may be limitless. Just as someone's bad mood can rub off on you, positivity, too, may spread, says Nicholas Christakis '88, an HMS professor of medical sociology and of medicine who has researched the contagion of emotions within the larger context of social networks. His findings have shown that happiness may be a collective phenomenon: Having a happy friend who lives within a mile of you, for example, appears to increase the probability that you will be happy as well. In collaboration with James Fowler at the University of California at San Diego, Christakis found similar effects for the spread of happiness between next–door neighbors, siblings that live nearby, and spouses—so that good feelings continue to move from person to person, even when there's no longer a direct connection to the original Pollyanna.

"Just as some diseases are contagious," Christakis says, "we've found that many emotions can pulse through social networks." And unlike the flu, happiness is a gift you can actually enjoy.

Perhaps, as Christakis's research suggests, that's the real key to a rosy outlook.

"Happiness isn't just one big event," Etcoff says, "but the accrual of smaller, incremental steps, such as feeling gratitude and helping others."

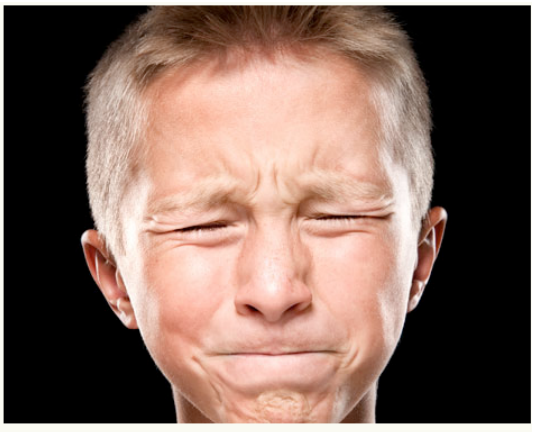
Christakis agrees. "Rather than asking how we can get happier, we should be asking how we can increase happiness all around us," he says. "When you make positive changes in your own life, those effects ripple out from you and you can find yourself surrounded by the very thing you fostered." ■

Jessica Cerretani, a former assistant editor of Harvard Medicine, is now a freelance writer in Dorchester, Massachusetts.

Anger Management

Scientists probe the nature of wrath in the hope of devising cures

by Elizabeth Dougherty
Harvard Medicine Magazine, Summer 2011



Joson/Getty Images

WHEN EMOTIONAL BRAKES FAIL

Depression and anger often go hand in hand

Flares and flashes. Outbursts and eruptions. The words used to describe anger tend to be volcanic. And science may explain why.

When an angry feeling coincides with aggressive or hostile behavior, it also activates the amygdala, an almond–shaped part of the brain associated with emotions, particularly fear, anxiety, and anger.
This finding is one in a series from studies led by Darin Dougherty, an HMS associate professor of psychiatry at Massachusetts General Hospital, that aim to uncover why anger attacks occur in patients with major depressive disorder. Some of these patients experience angry flare–ups that are inappropriate to the situation and out of character for the individual. "People will yell or throw things," says Dougherty. "We wanted to investigate the mechanisms behind those reactions."

For these patients, angry outbursts usually stop when the depression ends. Understanding this link could provide valuable insights into these disorders and their treatment.

Dougherty began in 1999 by investigating healthy people with no signs of depression and no history of angry episodes. He employed positron emission tomography imaging to examine which regions of the brain engage during angry moments. Subjects simulated angry moments by recalling the moments in their lives when they felt rage. "You can try to spark anger by showing upsetting pictures, for example," says Dougherty. "But the response isn't as robust. The best way to induce emotion is through autobiographical scripts."

During angry recollections, the amygdala fired. At the same time, a part of the orbital frontal cortex, just above the eyes, also engaged, putting the brakes on emotion. "Healthy people experience anger," says Dougherty, "but they can suppress it before acting on it."

In depressed people who are prone to anger attacks, this neurological brake fails to engage. In another study, Dougherty found that in people with major depressive disorder and anger attacks the orbital frontal cortex did not activate. Rather, activity in the amygdala increased and angry outbursts ensued. More recently, Dougherty used functional magnetic resonance imaging to achieve a more fine–grained examination of the timing of the amygdala's activation during angry moments.

Now Dougherty is applying these research techniques to examine what happens in the brain during treatment for anger and depression using drugs or cognitive behavioral therapy to better understand how treatments work mechanistically. Ultimately he hopes this work will give clinicians better insights into which treatment options might be best for patients.

STICKS AND STONES

Verbal abuse injures young brains

Everyone feels anger. Traffic snarls, unsympathetic colleagues, playground bullies; we all have our triggers. The problems start when anger boils over into hostility and aggression, behaviors that cause harm.

THE KIDS ARE NOT ALL RIGHT: Martin Teicher, pictured above, has documented the damage that parental verbal abuse wreaks on the brains of their children.
Rose Lincoln/Harvard News Office

According to research from McLean Hospital, seemingly harmless anger may cause invisible damage to the brains of young children. Martin Teicher, an HMS associate professor of psychiatry at McLean, has found that verbal abuse from parents and peers causes changes in developing brains tantamount to scarring that lasts into adulthood.

Teicher began his investigations by examining the effects of sexual abuse, physical abuse, and harsh corporeal punishment on young brains. In 2005, he turned his attention to parental verbal abuse, finding that verbal abuse had deleterious effects on par with witnessing domestic violence and other seemingly more violent forms of maltreatment. In 2009 he used diffusion–tensor magnetic resonance imaging to build an accurate map of the neural connections in the white matter of brains of adults who had experienced parental verbal abuse, but no other forms of abuse, as children.

He found three neural pathways that were disturbed in these adults: the arcuate fasciculus, involved in language processing; part of the cingulum bundle, altered in patients with post–traumatic stress disorder and associated with depression and dissociation; and part of the fornix, linked to anxiety. “The damage,” Teicher says, “was on par with that found in the brains of people who had experienced nonfamilial sexual abuse.”

More recently, Teicher found that peer verbal abuse—whether teasing, belittling, or disparaging words—can cause similar damage. “Kids often hear many negative things from their peers,” he says.

Teicher’s latest research suggests that parental and peer verbal abuse may affect children differently throughout development. When experienced during early childhood, verbal abuse can lead to somatization, the translation of emotions into physical illness. During middle school, it can increase the likelihood of drug abuse, anxiety, and depression. In high school, it can lead to increased anger and hostility.

"The expression of a lot of anger can be pathogenic," Teicher says. "Children especially suffer when anger is vented. Openly expressed negative, raw, and intense emotion is hard for many people to witness and can leave scars." That is, children's brains seem to turn down the volume on abusive words, images, and even pain. The result is diminished integrity in these sensory pathways.

Teicher is now investigating the effects of witnessing domestic violence. Early findings suggest that all sensory systems may be vulnerable to violence; abuse that is heard may damage regions distinct from those injured by abuse that is seen or felt. His work as a whole suggests that anger may deserve more attention from psychiatry.

"We've really focused on depression and anxiety as key emotions," he says. "But anger is a big problem. It's a problem when we express it too much and when we express it too little."

THE SOUND OF THE FURY

Turn off your phones. And televisions. And game consoles...

Everyone, from children to great–grandparents, uses electronic media, and media use will only grow more pervasive. At least, that's how Michael Rich '91, an HMS associate professor of pediatrics at Children's Hospital Boston, sees it.

Yet since the earliest days of television, electronic media has been a blame–taker. In the fifties, people worried that television would turn children into delinquents. Today, parents fear that violent movie scenes and game scenarios will breed anger, aggression, and violence. These accusations against media, Rich believes, come down to values–based arguments, not scientific evidence.

In the fifties, people worried that television would turn children into delinquents. Today, parents fear that violent movie scenes and game scenarios will breed anger, aggression, and violence.

Erik Dungan/Stock.Xchng

In an effort to drill down to media's true effects, Rich has launched a longitudinal survey study. "We're trying to create the media exposure equivalent of the Framingham Heart Study," he says. The pilot study, now in its third wave of data collection, involves an ethnically and socioeconomically diverse group of 126 middle–school students from Manchester, New Hampshire.

Rich began the investigation with computer–based self–interviews to understand each child's typical media use, health behaviors and health status. For one week, participants carry a Palm Pilot and video camcorder, soon to be replaced by a Smartphone, which they are randomly signaled to use during waking

hours to capture their locations, companionship, media use, focus of attention, and emotional state. After completing the 58–question form—which, given the media adeptness of the young participants, usually takes less than 90 seconds—participants make a quick 360–degree video of their environment. This video picks up environmental contexts, including media that go unnoticed by participants, such as loud music in the next room, a brother playing a video game in the same room, or even a billboard passing by outside a school bus.

An early result of the study is the research team's definition of an important new measure: the Media Involvement Index, a measure of overall media immersion. The team's hypothesis is that as children use media devices more frequently and concurrently, the children are more likely to show risks of adverse outcomes. The first findings, published in the February 2011 issue of the *Journal of Adolescent Health*, suggest that children with a higher Media Involvement Index have an increased risk of early alcohol use. Future results will explore how media involvement influences other adolescent health risk behaviors, from smoking to violence.

Michael Rich

Courtesy of Michael Rich

Rich aims to better understand the ways media affect people's health and intends to share this information through his online parenting column, Ask the Mediatrician. "In a way, urging responsible media consumption is like promoting food safety and traffic safety," he says. "You don't want to lecture people, but to give them facts so they can make informed decisions."

ALIEN THERAPY

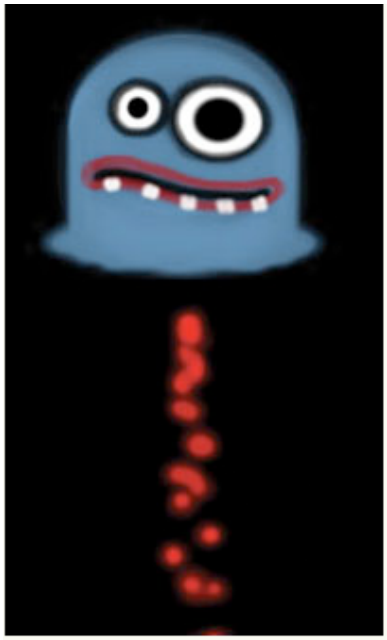
A video game trains angry children to keep their cool

Peew! Peew peew! Missed that alien! Peew! Peew! Oh, no! Just shot a good guy. Peew! Peew peew!

Welcome to RAGE Control (Regulate and Gain Emotional Control), a shoot–'em–up video game designed, as its name suggests, to teach anger management. This counterintuitive game—the kind often blamed for reinforcing behaviors that celebrate anger—works. The key element? When players' heart rates rise, indicating the emotional arousal that can lead to anger, their guns start shooting blanks. For adolescents who respond to minor stresses with angry and dangerous outbursts, the game may be an alternative to pharmaceutical interventions such as antipsychotics. In addition, says Joseph Gonzalez–Heydrich, an HMS assistant professor of psychiatry at Children's Hospital Boston and leader of the RAGE Control project, the game may enhance the effectiveness of behavioral therapy.

Unlike traditional biofeedback training, in which people learn to calm themselves by disengaging from reality, RAGE Control requires players to stay internally calm during an intense and frustrating activity. In this game, players must destroy googly–eyed aliens falling down the screen without harming the affable snails that squish past.
"We knew this type of game would force the kids to make decisions constantly while still keeping their arousal in check," says Jason Kahn, an HMS instructor in psychiatry who built and helped design the prototype. "Plus it would be something they would *want* to play." The game, modeled after Space Invaders, targets children aged eight and up.

The researchers combine game play with behavioral therapy that teaches such anger management techniques as deep breathing. The game also serves as an icebreaker for therapists. "The game provides patients with an opportunity to talk about their actions and feelings in the context of the game rather than having to revisit uncomfortable, demeaning topics such as past bad behavior," says Peter Ducharme, a clinical social worker at Children's Hospital Boston who is involved in the project. "Practicing the game lets them experience mastering the skills presented in therapy. This in turn allows them to open up about their difficulties."


Courtesy of Joseph Gonzalez–Heydrich

During the early stage of testing the game, the researchers recruited children who were inpatients in a psychiatric unit. "The alternative treatment for these kids would be antipsychotic drugs, which have a host of side effects and don't get at the root of the problem," says Gonzalez–Heydrich. "You don't learn to control your aggression by taking antipsychotics."

A recent trial of the game compared patients receiving the normal course of treatment with those receiving psychotherapy coupled with game play. Gonzalez–Heydrich cautions that the study was small, and that a larger, randomized controlled trial has started. At the same time, he says, "The game intervention had a profound effect. The kids reported feeling less angry."

THEM'S FIGHTIN' WORDS

Serotonin and dopamine drive aggression in fruit flies

Raised in isolation, he had no role models. He had never even witnessed a fight. Yet when he stepped into the ring, he had all the moves. He postured, lunged, and boxed, dancing like Muhammad Ali and jabbing like Sugar Ray.

How did he feel when he faced his first foe? Angry? Frightened? It is a question for the ages, for our victorious pugilist is a fruit fly.

“We don’t know when flies are angry,” says Edward Kravitz, the George Packer Berry Professor of Neurobiology at HMS, who studies fruit–fly aggression. “We can’t ask the animals how they feel.”

What Kravitz *can* ask, however, is what drives this innate aggressive behavior. Such research, although it does not translate directly to human anger, can provide insights into hostility and bullying. Kravitz saw similar unlearned, unpracticed fighting instincts in lobsters, making the question about hardwired anger even more curious. He selected flies as a model for teasing out the genetics, though, because flies can be bred rapidly and raised in complete isolation.

Kravitz has found that flies show aggressive behaviors when they face competition for resources, such as food or a mate. At first, they all fight the same way, but over time, winners and losers emerge. “Losing flies develop a loser mentality,” says Kravitz. They fight less aggressively against opponents they’ve lost to before and, even though they approach new foes with gusto, they tend to keep losing.

COME OUT SWINGING: Edward Kravitz's research team has found that during half–hour fights, fruit flies average 27 encounters of 11 seconds each. The skirmishing flies move so quickly that the researchers need slow–motion instant replay to score them.
Arlindo71/istockphoto.com

Even bullies, the victors who keep picking fights and winning, will lose their competitive advantage after just one loss.

In recent work, Kravitz bred flies with “tunable” aggression. In these transgenic flies he can selectively turn on and off neurons that contain serotonin and dopamine to determine what roles these neurons play in aggression, fight intensity, and the creation of pecking orders.

Serotonin, he found, is crucial for fight intensity. Without it, flies will not do battle with gusto. Dopamine appears to inhibit aggression: In its absence, flies fight at higher intensity levels. Kravitz and colleagues plan to isolate the specific neurons involved and work out the circuitry that governs these behaviors.

While it’s tempting to relate such findings to humans and their mood disorders, Kravitz avoids such equations. “We are after general principles of how these neural circuits work, and some of the chemicals are the same across species,” he says. “But the details of the circuitry are going to be completely different.” ■

Elizabeth Dougherty, a former science writer at HMS, is now a freelance science writer and novelist living in central Massachusetts.

The Chill of Fear

Dread requires only a tenth of a second to take root

by Ann Marie Menting
Harvard Medicine Magazine, Summer 2011

A copse can beckon, with its dappled leaves and songbird trills. But linger past twilight, and tree, bush, and animal assume different dimensions. Trunks thicken and loom, bushes snatch at clothing, and the rustlings and skitters of feather and claw magnify. You become unsettled, unnerved. You *run*.

You do this because you're afraid. Even without direct evidence of danger, you're compelled to flee, to protect yourself. Why this compulsion? It's the work of your amygdala, a tiny almond–shaped structure in your brain. Sensory signals alert it; in turn, it triggers a cascade of activity, deluging your body with messages that widen your eyes, prick your ears, accelerate your heart, quicken your breathing, wrench your stomach, moisten your palms, and launch a full–body, organ–clenching, corpuscle–filling chill. You run quite simply because fear grips you.

"You could call the amygdala a relevance detector," says Nouchine Hadjikhani, an HMS associate professor of radiology who specializes in capturing the activity of the brain as it reacts to fear–provoking stimuli. "In less than 100 milliseconds, just one–tenth of a second, sensory information reaches the amygdala, which signals your brain to be aware. All your systems become more receptive. You're now ready to fight, freeze, or flee."

The good news is that, should the terror prove benign, you'll not long be in fear's thrall. For while your amygdala is providing survival insurance by spurring action, sensory clues are also traveling to your prefrontal cortex. The amygdala's action buys you additional milliseconds, during which you might glimpse a light, stumble upon a traveled road, or receive other sensory stimuli that your prefrontal cortex will use to temper the initial response. You will calm, completing an arc of reaction that has been key to mammalian survival through eons.

Nouchine Hadjikhani
Graham Gordon Ramsay

Investigating what drives that arc of reaction spurs much of today's research into the molecular mechanisms of the fear response. HMS scientists are providing tantalizing insights by explaining how we decipher danger in the gazes or body movements of others, by informing treatments for conditions such as post–traumatic stress disorder, and even by providing clues to the gender–based underpinnings of human response to fear.

FEAR FACTORS

A 2005 poll of U.S. teenagers revealed the power that emotion can have in searing fear–filled memories deeply; despite the teens' limited direct experience, terrorist attacks, war, and nuclear war held top–ten berths in a list of fears. This finding hints at a phenomenon that Hadjikhani and her colleague's study: the contagion of fear. In her research, Hadjikhani has found that humans, like other animals, can experience fear indirectly, the result of another's glance or muscle tensing, or, on a larger scale, that electric connection that turns a milling crowd into a stampeding throng.

"We're born into this world with a system to read other people's expressions," says Hadjikhani. "Ten minutes after we're born, we're already oriented more to faces than to objects." In 2008, Hadjikhani and colleagues reported on their investigation of one aspect of facial expression—the gaze—and its role in communicating danger. They found that while a direct gaze from a fear–filled face triggers activity in fear–response regions of the brain, the response is not as complex as that elicited by a fear–filled face in which the eyes are averted. A direct gaze signals an interaction between participants who know themselves to be non–threatening. But an averted gaze, "pointing with the eyes," as the researchers call it, flags a possible environmental danger and sparks activity in brain regions skilled at reading faces, interpreting gazes, processing fear, and detecting motion.

In other research, Hadjikhani found that the brain can recognize happy and fearful expressions in body movements. A fearful posture—hands held open and in front of the body like shields, for example—activates brain regions that oversee emotion, vision, and action, while postures of happiness—arms loosely held from the body as if opened to embrace—spur activity only in vision–processing regions.

These physical communications of actual or perceived danger offer one avenue to developing a conditioned fear, a learned response founded upon emotion and impressed so firmly within memory that it remains active for a lifetime.

RAISING THE DREAD

According to the National Institute of Mental Health, roughly 19 million people in the United States have mental illnesses that involve persistent, outsized fear responses to seemingly ordinary stimuli. A door slam becomes a gun's report to a shattered combat veteran, for example, while smoke from burning leaves might trigger smell–based memories of pyres for a genocide survivor. Among the anxiety disorders linked to conditioned fear responses is one that's much in the news: post–traumatic stress disorder.

Vadim Bolshakov

Rose Lincoln/Harvard News Office

For more than a decade, Vadim Bolshakov, an HMS associate professor of psychiatry and director of McLean Hospital's Cellular Neurobiology Laboratory, has explored fear–driven disorders by investigating their molecular bases in the brains of rats. One early finding from his laboratory showed that learned fear changes the way the animals' brains operate, offering a mechanism for conditioned fear's persistence.

Bolshakov and colleagues taught rats to associate a harmless stimulus, a tone, with a painful event, a shock to their feet. The researchers found that neurons in the rodent amygdala exhibited remarkable sensitivity to the tone, so much so that the neurons continued to fire after the stimulus was removed. This sensitivity, known as long–term potentiation, is important to memory acquisition. It is normally modulated by glutamate, a chemical that is released into the synaptic spaces between neurons when a message is being passed, but then is deactivated to prevent message over–expression. Bolshakov's team showed that the amygdala's heightened sensitivity was the result of too much glutamate, either because the clean–up process failed or, as the researchers postulated, because production of the chemical went into overdrive.

Other studies by Bolshakov and colleagues identified two proteins essential to the innate and learned fear responses. When the researchers blocked production of one of the proteins, stathmin, fear–conditioned mice were less able to recall the learned fear—and lost the ability to recognize dangers that normally would have kicked their innate fear response into high gear. Blocking the gene that produced a protein known as transient receptor potential channel 5, normally found in high concentrations in the amygdala, decreased the rodents' neurons' sensitivity to cholecystokinin, a neuropeptide released when the innate fear response is triggered or a learned fear is recalled.

These insights are welcomed by Roger Pitman, an HMS professor of psychiatry, and Mohammed Milad, an HMS assistant professor of psychiatry. Based at Massachusetts General Hospital, these researchers seek to tease out treatments for people with anxiety disorders such as post–traumatic stress disorder.

LOCATION, LOCATION, LOCATION

Roger Pitman

John Soares

"You can never completely abolish a learned fear," says Pitman. "Learned fears are deep and may strengthen by reconsolidating after recall. One way to help patients diminish the impact of an anxiety–producing memory is to guide them to form a new memory that inhibits, or extinguishes, expression of the fearful memory during any recall attempt."

Or, as Pitman and colleagues discovered several years ago, people might be helped to stave off a fear–filled memory by preventing it from consolidating in the first place. In a controlled study of patients entering Mass General's emergency department after traumatic experiences—assaults or car accidents, for example—Pitman provided some participants with a placebo and others with propranolol, a drug that blocks the effects of the hormone adrenaline. At follow–up interviews participants listened to audiotapes of their own accounts of their trauma the day it occurred. Propranolol recipients had weaker physical responses to the tapes than placebo users, who showed physical signs of the stirring of their fearful memory despite time's passage.

Replicating these results has proven difficult, however, so Pitman and colleagues have shifted their focus to reactivating traumatic memories in people with post–traumatic stress disorder and then administering an anti–stress drug to try to weaken the memory's reconsolidation.

Reliving a fear, even a trauma–induced one, is not necessarily pathologic, Milad points out. Recalling the source of high emotion or injury can serve as a safeguard, a warning that our brains can tap as needed. In addition, time often softens the intensity of response.

"Say you're in a car accident," Milad adds. "It occurs at a particular intersection at the same time a certain song is playing on the radio. For a period following that accident, whenever you go through that intersection or hear that song, you will re–experience at some level your initial fear. If over time nothing horrible happens to rekindle your memory, your conditioned response to either stimulus will lessen until the fear is extinguished. This extinction doesn't erase the initial learned fear; instead, it leads to forming a new memory, a 'safety memory.' The learned fear—the neuronal connections that the experience formed

within your amygdala and between your amygdala and certain cortical structures—remains."

For some, the trauma never lessens. In people with post–traumatic stress disorder, Milad and Pitman have found that two brain regions involved in extinction, the hippocampus and a region of the prefrontal cortex, function at a lesser capacity, while activity in the amygdala and the dorsal anterior cingulate, a region involved in cognition and motor control, rachets up. These findings may explain the unending rawness that trauma–induced fears bring to people with the disorder.

X FACTOR

Other research by these investigators suggests that hormones and biological cycles may play significant roles in fear learning and extinction.

"Although some data suggest that estrogen actually enhances fear learning," says Milad, "other studies suggest the opposite, that it reduces fear and anxiety. Unfortunately, the area is underinvestigated. Anxiety disorders, for example, are twice as high in women—and we can't say precisely why."

Mohammed Milad

John Soares

The researchers' work does provide intriguing clues, however. They have found that women with higher estrogen levels showed stronger activation of the ventromedial prefrontal cortex, a brain region key to fear control. These high–estrogen women were good at extinguishing fear. When the researchers repeated the study in rats and manipulated estrogen levels, they found that blocking estrogen impaired the animals' ability to control fear. Reintroducing estrogen caused the rats to behave as if they felt safe.

Curiously, the researchers found that men's ability to control fear was akin to that of high–estrogen women. How does it jibe, then, that women have twice the prevalence of anxiety disorders?

"We don't know," says Milad, "but the speculation is that estrogen alone doesn't make you a super–extinguisher. It may be the lack of the hormone that puts a woman at higher risk. If a woman's estrogen is high, she controls fear in a way comparable to men, but if her estrogen dips, as it would during a normal menstrual cycle, she may be at a higher risk for fear acquisition following a trauma or another emotion–laden incident."

Such studies by Milad and others highlight a growing interest in finely parsing the mechanisms of fear acquisition and extinction in humans. Fundamentally, though, our

response to fear remains basic, a primitive emotion essential to our survival and a core response that unifies our species.

"The amygdala is the amygdala," says Milad. "Whether it's in Taipei or in Cedar Rapids, it's still a knee–jerk response to danger." ■

Ann Marie Menting is Associate Editor of Harvard Medicine.

The Depths of Despair

Medicine tackles melancholia with new tools and understanding

by Elizabeth Dougherty
Harvard Medicine Magazine, Summer 2011

TUNING OUT SORROW

Deep–brain stimulation offers hope for depression

THROWING A LIFELINE: Darin Dougherty has found that deep–brain stimulation can offer hope to those with intractable depression.
Rose Lincoln/Harvard News Office

Some people with depression have tried everything—behavioral therapy, antidepressants, sleep deprivation, electroconvulsive therapy—to no avail.

Now deep–brain stimulation is showing promise for people whose condition is refractory. The therapy, already used in some Parkinson's patients to control tremors, involves implanting electrodes in a region of the brain found to be active during sadness–induction studies.

Darin Dougherty, an HMS associate professor of psychiatry at Massachusetts General Hospital, was principal investigator of a study of five of the world's first fifteen implantations ever attempted to control depression. The procedure, initial studies of which began at Mass General in 2003, involves the surgical insertion of electrodes into the brain's ventral capsule/ventral striatum. After implantation, the physician must tune the electrical stimulation for each patient, after which the device can stimulate the patient's brain continually, even indefinitely. If the device fails, as can happen when the person walks through a theft detector or airport screening device, the depressive symptoms quickly return.

In a follow–up study published by Dougherty and others in a 2009 issue of *Biological Psychiatry*, patients showed response rates of 40 percent after six months and 53 percent after one to four years; those responding showed significant improvement. For a patient to consider such an invasive treatment, their symptoms must be grave. “The degree of illness really highlights the robustness of the treatment,” says Dougherty.

A large–scale clinical trial of the technique is now under way, involving more than 200 patients at 20 different sites. Dougherty is hopeful that an interim review of early results by the U.S. Food and Drug Administration will be one more step toward approval of this experimental treatment.

PRIMITIVE BRAINS

Adults lose their reactivity to sad faces

Is sadness a survival emotion? In 2004, William Killgore, an HMS assistant professor of psychology at McLean Hospital, investigated whether the perception of sadness might be governed by the same unconscious processing as fear or anger. “Our findings indicate that while other emotions have primitive survival value,” Killgore says, “sadness appears to be more of a social emotion.”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Killgore arrived at this conclusion after investigating whether the subliminal suggestion of sadness triggers activity in the brain’s amygdala, a region linked with unconscious, survival–related responses, such as the startle reflex and the fight–or–flight response. In this study, Killgore showed adult participants faces wearing sad expressions. Each sorrowful visage appeared for 20 milliseconds before Killgore masked it with one whose expression was neutral. While viewing the sad faces, participants had no conscious awareness of them, Killgore found. Unlike angry, frightened, and happy expressions, which in earlier research had all produced spikes in amygdala activity, the subliminal sad expressions elicited no such response.

In 2007 Killgore repeated his study with adolescents. These participants showed an unconscious response in the amygdala to sad expressions, suggesting, Killgore says, that young brains may not be ready to distinguish some social emotions from threats. It may be that we learn as we mature to distinguish social cues from primitive survival responses or that we learn to distinguish aroused happy, angry, and frightened faces from subdued, sad ones. Or, Killgore adds, it could be both. He recently found that the amygdala responds in the same way to both happy and frightened expressions, lending support to the arousal hypothesis.

The difference between adults and adolescents does suggest, however, that in youth, "the amygdala is still responsive to a broad range of emotional stimuli," says Killgore. "In adults, the prefrontal region puts the brakes on to better modulate or control responses to social emotions."

PERSONALIZED PSYCHIATRY

Researchers hope to be able to predict the success of antidepressants

More than half of clinically depressed patients don't respond to their initial treatment, and weeks often pass before this failure becomes obvious. Each subsequent treatment requires additional weeks to assess. Yet this process needn't be a trial–and–error one, says Diego Pizzagalli, an HMS associate professor of psychiatry at McLean Hospital. Pizzagalli hopes to speed the search for efficacious therapies for depression, not with new medications, but with biomarkers.

"We want to personalize treatment in psychiatry," he says, by giving psychiatrists the tools to find the best path to recovery for each patient. The science is not there yet, he adds, but it may be soon.

A decade ago, Pizzagalli's laboratory discovered that a region of the brain called the rostral anterior cingulate cortex shows elevated activity among people who, though not yet treated for depression, would go on to respond to the treatment months later. This biomarker for elevated activity identified 89 percent of eventual responders; its absence was linked with 89 percent of eventual nonresponders. More than a dozen studies have since replicated this finding.

"The next challenge," Pizzagalli says, "is to find a more treatment–specific predictor." He is part of a group of researchers who recently received funding to do just that. A National Institute of Mental Health grant supports six sites nationally, including McLean Hospital, where Pizzagalli is the principal investigator, and Massachusetts General Hospital. The investigators will recruit 400 patients nationally and collect a range of data, including genetic profiles, clinical symptoms, brain scans using electroencephalography and functional magnetic resonance imaging, and any experience with depression–linked environmental factors, such as stress and early trauma. They will then correlate those data with treatment outcomes.

"We want to see if these data can be combined to derive novel ways for guiding treatments for depression," says Pizzagalli. "We hope to find the next generation of predictors."

THE PATH TO SADNESS

The roots of depression can be uncovered

UNDER PRESSURE: Randy Auerbach has found that teens who receive little support from their parents and classmates are more likely to be susceptible to stress–triggered depression.

John Soares

When it comes to triggering sadness and depression, which comes first, stress or vulnerability? Randy Auerbach, an HMS instructor in psychology at McLean Hospital, suspects it's both.

"The presence of stress isn't enough, and neither is the presence of vulnerability," he says. "It's the interaction of these two risks that converge and pave the path to sadness and depression."

Auerbach's research aims to tease out depression's genesis by studying the interplay of stress with such vulnerabilities as low self–esteem, dysfunctional attitudes, self–referential processing, and a perceived lack of control in the face of adverse events. He focuses on adolescents because 20 percent of people in this age group experience a depressive episode, and most will relapse in adulthood.

Auerbach recently examined the relationship between social support and stress and the development of depression among adolescents. He found that young people with little support from parents and classmates are more likely to experience depressive symptoms in the face of stress. A lack of friends and supportive peers, however, did not contribute to risk for depression.

As a clinician, Auerbach applies his integrated, holistic model by helping patients learn to recognize their feelings, frailties, and susceptibilities so they can move from being reactive to proactive. Someone who feels test anxiety to the point of poor performance, for example, may learn to predict that anxiety, employ relaxation techniques, and interrupt the vicious cycle of stress, avoidance, and impaired function.

"Depression is complex," says Auerbach. "Once we have an understanding of the factors that affect the unfolding of depressive symptoms, we can target them and reduce the despair." ■

Elizabeth Dougherty, a former science writer at HMS, is now a freelance writer.

The Look of Love

Love's many splendors begin with empathy and attachment

by David Cameron
Harvard Medicine Magazine, Summer 2011

When second grader Jacqueline Olds arrived home from school one afternoon in 1955, she found the atmosphere charged with excitement. Her parents pointed to a headline on the front page of the *Montreal Star*: "McGill opens vast new research field with brain 'pleasure area' discovery."

Olds, now an HMS associate clinical professor of psychiatry at Massachusetts General Hospital, had only vague notions back then of what her father, James Olds, then a postdoctoral researcher at McGill University, did during the day, yet she knew it had something to do with the brains of rats.

Painting: "Pair of Lovers," by Pal Szinyei Merse (Photo by Alfredo Dagli Ori/The Art Archive/Corbis)

The elder Olds had just published a paper in the *Journal of Comparative and Physiological Psychology* describing how the rat brain was suffused with desire when a particular region of it was electronically stimulated. The rat would do whatever it could to relive the cerebral voltage regardless of cost, like a jilted lover seeking intimacy anew, or a gambler circling back to the roulette wheel. James Olds's discovery of the brain's "pleasure center" has held up for more than half a century, and no scientific discussion on the phenomenon of human love can avoid it.

Most of us, even those disciplined to interpret the world through the lens of evidence–based science, can't help but imagine love as a ghost in the machine. St. Paul's famous meditation on the patience and kindness of love, recited in a seemingly nonstop wedding loop, personifies love as an entity embodying what we crave most in others. Love as a spiritual value has so permeated Western culture that even a science–drenched modern

fable like the film *Eternal Sunshine of the Spotless Mind* couldn't help but bust it out of its neurophysiologic sheathing.

But the scientific evidence is unmistakable: Whatever this thing called love is, we humans need it. Deep attachments to others—and the pleasure–center stimulation those links cause—are as vital to our bodies and minds as food and sleep. Their absence carries catastrophic risk to our health and well–being.

I FEEL YOUR PAIN

While many drugs, including antibiotics and certain chemotherapies, gradually lose effectiveness over time, one treatment has manifested a steady rise in potency during the past few decades: the placebo.

Carl Marci

Rose Lincoln/Harvard News Office

Much to the vexation of pharmaceutical companies trying to get antidepressants and pain medications approved for use, clinical trials conducted over the years have revealed the increasing power of the placebo effect. Our efforts to understand that trend throws light on the healing power of doctor/patient connectedness.

Carl Marci '97, an HMS assistant professor of psychiatry at Massachusetts General Hospital, began paying attention to the placebo effect in the early 1990s, while still a medical student. During a course on alternative therapies, he was struck by the amount of time these practitioners of homeopathy, Reiki, and acupuncture spent with their patients.

"Data showed that, with the exception of intense psychotherapy, people were spending far more time each year with alternative practitioners than they were with other health care providers," says Marci. "That got me thinking about the relationship." He began to suspect that the success of these providers had less to do with their therapeutic approach than it did with the time they invested in their patients. He has since spent most of his professional life studying the doctor/patient relationship, using empathy as his framework.

What is empathy, and why does it matter? The term, coined by a contemporary of Freud, goes back to the German word meaning "feeling into." The English novelist Ian McEwan once wrote, "Imagining what it is like to be someone other than yourself is at the core of our humanity. It is the essence of compassion, and it is the beginning of morality."

A slightly more scientific paraphrase might describe empathy as the ability of the brain to accurately mirror the emotions it perceives in another. Marci's contribution to this field is the discovery that most empathy occurs at an unconscious level, evidence that our brains are hardwired for it.

Several years ago Marci conducted a study in which he sought to quantify empathy. Taking 20 patient/therapist pairs, he and colleagues measured the rate at which skin conducted electrical impulses in these subjects, as determined through their sweat production during sessions.

"Skin sweat marks arousal coming from the brain's emotion center, and it accurately measures the depth of emotional response," says Marci. "It can't indicate what you're feeling, but it indicates the depth and the curve, the trajectory, of your emotion."

Marci found that at the moments when the rate of electrical conductivity on the skin of patients and therapists synchronized into matched lines of peaks and gullies, the patients reported feeling most understood. (Interestingly, conductivity was most disjointed precisely at those moments in which the therapists monopolized the conversation.)

Since the mid–1990s, when a group of Italian researchers first proposed the idea of "mirror neurons," researchers have come to grasp that our brains contain dedicated neuronal networks that reflect the world around us. These networks, which reside primarily in the prefrontal cortex—the corner office of cerebral executive function—imitate motions and emotions in a neurobiological monkey see, monkey do. When you witness someone waving, the very part of your brain that activates arm motion and wrist action lights up, even if you jam your hands into your pockets. And despite your efforts to keep your visage impassive, the neurons that animate faces to form beaming smiles flare the nanosecond you glimpse a Cheshire grin. "Our brains are so wired for empathy," Marci says, "that there's zero lag time."

As far as the placebo effect goes, Marci suggests that one explanation for its steady rise is the increasing complexity of clinical trials. The tighter the regulations, the more interactions patients have with a team of providers. The deeper human interaction that presumably results may help explain the increase in the placebo effect.

Which leads us back to the brain's pleasure center, or reward center. Empathy triggers dopamine and serotonin, neurochemicals associated with the reward center's conjoined twin, the brain's emotion center. If, as the scientific literature indicates, mere laughter stimulates the reward center, how much more stimulating would be the act of immersing yourself in the world of another?

From an evolutionary perspective, this makes perfect sense. "Human babies have the most postnatal neuronal growth of any species," says Marci. "Without empathy, there is no attachment, and attachment is essential for survival."

GOOD CHEMISTRY

What happens when empathy is absent? While Marci's model is the doctor/patient relationship, Karlen Lyons–Ruth, an HMS associate professor of psychology at Cambridge Health Alliance, studies the physiological effects of human interactions in a relationship far more primordial: the one between mothers and infants.

Within the field of developmental psychology, Lyons–Ruth is a leading expert on attachment, with a particular focus on attachment gone wrong. "In a sense," she says, "I'm most interested in what happens when love goes awry."

Empathy and mirroring of the infant's states by the parent is a powerful regulator of normal development, says Lyons–Ruth. The biomarker she uses to measure the quality of a mother–infant relationship is cortisol. This steroid hormone has a number of functions, such as increasing blood sugar and helping the body metabolize fats and carbohydrates. It is also released in response to stress to help the body mobilize to meet a challenge. Yet too much cortisol can lead to health problems.

Combat soldiers in particular are likely to experience long periods of extreme stress. Such prolonged stress keeps the hormone jacked up, but the human organism's capacity to tolerate such a powerful chemical is limited, so an emergency system clicks in and dams the hormone's flow. This check can result in an individual who goes through life with a blunted stress response system and attenuated emotional engagement.

Normal cortisol levels and stress responses are essential for healthy attachment, says Lyons–Ruth. When a mother's cortisol levels are normal, she acts as an external regulator by being attuned to her baby's fear and discomfort and acting to relieve these negative states. As a result, the baby experiences minimal stress. But when a mother's cortisol response is blunted, her ability to act as an attuned external regulator for the infant may fail.

"We still have much work to do to understand this model of attachment," says Lyons–Ruth. "But our research has shown that mothers whose interactions with their infants are the most disrupted have the lowest cortisol levels." She and her colleague Bjarne Holmes have also observed that the infants of low–cortisol mothers present with low cortisol levels as well. When low–cortisol infants are stressed, though, their cortisol levels fly off the charts. "These babies lack the ability to modulate their stress responses," Lyons–Ruth says. Because antisocial children and adults also show blunted cortisol responses, low cortisol levels among mothers with very young infants set off alarm bells about these babies' future development.

Infants reared in orphanages may be most at risk for blunted stress responses and associated disturbances in their ability to form deep emotional bonds. As Megan Gunnar and her colleagues at the University of Minnesota have shown, many children adopted from orphanages show abnormally low hormone levels similar to those of combat veterans and

antisocial adults. But instead of acting antisocial, some of these children exhibit what Lyons–Ruth calls indiscriminate friendliness. They lack the "stranger danger" instinct that is recognized as a healthy component of early development. Indiscriminate behavior often persists throughout childhood, even after adoption into healthy and stable homes.

"The work that Charley Zeanah has done at Tulane is pointing to a possible critical period for the formation of attachment bonds," says Lyons–Ruth. "Despite good care later, unless responsive care is provided before the end of toddlerhood, blunted cortisol and attachment problems can persist."

LONELY HEARTS CLUB

Richard Schwartz has the distinction of being both an HMS associate clinical professor of psychiatry at McLean Hospital and the husband of Jacqueline Olds, the psychiatrist whose father discovered the brain's reward center. Together Schwartz and Olds have carved out a niche as experts in the study not only of love and marriage, but of loneliness as well.

They had already written one book on loneliness when a University of Chicago survey found, in 2004, that 24.7 percent of respondents had not spoken to anyone over the prior six months on issues that were important to them. Most striking was that nearly two decades earlier, only 10 percent of respondents taking the survey had reported this circumstance. This finding spurred Schwartz and Olds to tackle a second book on the subject, *The Lonely American*. Their thesis is straightforward: The United States is suffering from a loneliness epidemic, and the feeling is leading to physical and mental stress. "To put it simply," says Schwartz, "loneliness is bad for you."

Jacqueline Olds and Richard Schwartz

John Soares

And there's plenty of evidence to support this notion. In 1988, University of Michigan sociologist James House published a seminal review article in *Science* that detailed a link between loneliness and premature death. Even when circumstances such as accidents were factored out, socially isolated individuals were twice as likely to die within a ten–year period as were non–isolated people.

Maintaining contact with others seems to be hardwired into our biology, such that our bodies become stressed when these connections are threatened. Loneliness, in short, is a form of low–level chronic stress.

"When you're disconnected, your immune system goes to hell," Schwartz observes, citing another landmark study, this one published in *Genome Biology*

in 2007 by Steve Cole of the University of California at Los Angeles. In this study, researchers found that chronic loneliness alters the expression of a network of genes associated with inflammation. “If we know that loneliness affects our immune response,” Schwartz says, “it’s not surprising that it would happen at the level of DNA expression.”

As therapists, Schwartz and Olds constantly encounter patients who suffer from chronic loneliness, yet most are hesitant to label it as such. As diagnoses go, depression and anxiety are less embarrassing. But it’s hard to overestimate the psychic pain that loneliness can cause. Think of the nibbling feelings you had as a child (or an adult!) when you suspected you were being purposely left out. Then try to imagine the pain of ostracism or, taken to extremes, the outright torture of solitary confinement.

“Few higher mammals are solitary,” observes Schwartz. “Humans are relatively helpless as individuals in the natural world. Part of what makes us so powerful is that we’ve banded together in small groups. And part of the pain of loneliness is the recognition that without other people we simply can’t survive.”

Nor surprisingly, loneliness and substance abuse often go hand in hand. “Many drugs, particularly stimulants, trigger the dopaminergic reward center,” Olds says. “But we now know that social connectedness and the feeling of being loved also activate that same reward center. If you lack the relationships needed to stimulate that part of your brain, you’ll likely find it in a drug.”

Blanche DuBois’s legendary line in *A Streetcar Named Desire*, “I have always depended on the kindness of strangers,” is evolutionarily and neurologically true. Empathy and attachment are at the core of human relatedness, and a small section of our prefrontal cortex drives us to find it one way or another. Without it, we’re lost.

“Attachment to others,” says Olds, “is the original reward.” ■

David Cameron is the Director of Science Communications at Harvard Medical School.

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Boston Psychoanalytic Society and Institute, Inc.
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