ON THE BRAIN

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Tackling Dyslexia at an Early Age

Researchers at HMS and Boston Children's Hospital who have been studying dyslexia in children have identified differences in the brain activity of at-risk children as young as ages 4 or 5. Typically, this language processing disorder has been difficult to diagnose before ages 7 or 8, when formal reading instruction usually begins. The findings by the HMS researchers mean that very young children at risk for dyslexia could take part in early intervention programs that may help to ward off learning difficulties before these children enter kindergarten.

In the study, published in the *Proceedings of the National Academy of Sciences* in 2012, the researchers performed MRI brain scans on preschool children while the children completed a number of tasks, including deciding whether two words start with the same sound or with different sounds. The scientists discovered that children with a family history of dyslexia—an older sibling or a parent with a clinical diagnosis of dyslexia—showed less activity in regions of the brain involved in language and information processing than did children with no family history of the disorder. The brain regions the researchers monitored are areas critical to reading and learning.

Commenting on the study at the time of its release, senior author Nadine Gaab said, "We know that older children and adults with dyslexia have dysfunction in the same regions of the brain. What this study suggests is that the brain's ability to process language sounds is deficient even before children have been taught to read." Gaab is an HMS assistant professor of pediatrics and a research associate at the Developmental Research Medicine Center at Children's.

Reading fundamentals

People diagnosed with dyslexia have difficulty distinguishing speech sounds and learning how those sounds relate to words and letters. These difficulties affect children's ability to read. Developmental dyslexia (dyslexia that is not caused by a brain injury after a child has learned to read) affects between 5 and 17 percent of children in the United States. For children in families with a history of the disorder, up to 50

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People diagnosed with dyslexia have difficulty distinguishing speech sounds and learning how those sounds relate to words and letters.

percent struggle with reading. Some of the signs that may indicate a child is struggling with dyslexia include reading well below an age-appropriate level, having difficulty processing and understanding spoken words, having difficulty identifying similarities and differences in letters and words, learning new words slowly, being unable to sound out the pronunciations of new words, and having problems reading paragraphs fluently and comprehending the text. Contrary to popular belief, the disorder is not a problem of word or letter reversals, writing, for example, a *b* for a *d*: Writing words or letters backward is fairly common among all children who are learning to read.

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It's all about the brain

Years ago, children with developmental dyslexia were thought to be lazy and unmotivated, a misperception that, unfortunately, still exists. Scientific study, however, found the disorder is not based in behavior but rather in the fact that the brains of children with the disorder are fundamentally different from those of their non-dyslexic peers.

The human brain is divided into right and left hemispheres. Most of the areas responsible for language processing, speech, and reading are located in the left hemisphere. These areas include the frontal lobe, where Broca's area is a center for speech organization and production; the parietal lobe, where language sounds are mapped with their written counterparts (spelling); the temporal lobe, where verbal memory resides; and the occipital lobe, home of the visual cortex, which processes letter identification. Studies suggest that children with dyslexia show slower activation in all parts of the reading network, but primarily in the temporal and parietal lobes during the first years.

Studies also show structural differences in the brains of children with dyslexia and their non-dyslexic peers. People with dyslexia have less gray matter, the nerve cells used for the information processing so critical to sensory learning, than non-dyslexics. This structural difference could contribute to difficulties with phonological awareness, which is the ability to hear and process the sounds that make up words in spoken language. Many dyslexics also have reduced white matter integrity when compared with that in people without the disorder. White matter forms the "highways" through which different regions of the brain rapidly communicate with one another.

In a follow-up study in 4- to 8-month-old infants, Gaab and her colleagues found differences in white matter in at-risk infants. In MRI scans of the infants' brains, Gaab found the areas of white matter "showed reduced integrity in children with a family history of dyslexia." The scientists speculate that the regions required to process language may be less efficient when there is less white matter available for cross-brain communication.

Interventions that work

With early intervention, many children at risk for dyslexia can become skilled readers. In fact, says Gaab, one meta-analysis showed that up to 70 percent of at-risk children who receive educational intervention in kindergarten or first grade become proficient readers. Many interventions focus on phonological processing (an auditory skill that analyzes and manipulates the sound structure of words), structured reading schemes that involve repetition, and the measured introduction of new words.

Some of the more popular interventions stress simultaneous, multisensory learning approaches that combine auditory, visual, and kinesthetic (learn-by-doing) modalities. Although there is little empirical data supporting the use of one program over another, Gaab says that these various interventions can be appropriate for preschool-age children.

Gaab and her colleagues are now following children over time to see if the brain patterns they observed in their earlier study correlate with a later diagnosis of dyslexia. The researchers also are following the children in the *PNAS* study to see how the children's brains develop over time.

Although children with dyslexia can become better readers, there is evidence that they will continue to have difficulty reading as they get older. "If you truly have dyslexia," says Gaab, "your brain is fundamentally different and will develop fundamentally differently. It's not something that remediates by itself."

Interrupting Neuronal Function in Parkinson's Disease

In the late 1980s, an innovative surgical technique brought new hope to those suffering from Parkinson's disease, a progressive neurodegenerative disorder. The technique, known as deep brain stimulation (DBS), offered a new way to inactivate parts of the brain that contribute to the symptoms of Parkinson's disease; previous methods relied on heated probes that were surgically introduced into the brain to kill the tissue contributing to the disease's symptoms. Today, DBS is an approved treatment for Parkinson's disease and other movement disorders and, according to the National Parkinson Foundation, has been used to treat more than 100,000 people worldwide.

DBS does not permanently damage the brain, yet it can successfully modulate those parts of the brain that contribute to such Parkinson's symptoms as tremors, rigidity, stiffness, and slowed movement. "We have evidence that DBS may actually interrupt the regular, rhythmic firing of groups of neurons in the deep structures of brain," says Ludy Shih, an HMS assistant professor of neurology and director of the Deep Brain Stimulation Program at Beth Israel–Deaconess Medical Center.

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Murky mechanisms lead to reduced symptoms

For DBS, electrodes, implanted in brain tissue, are attached to a pacemaker-like device that is implanted just below the collarbone. When the device is activated, continuous electrical pulses, sent to the electrodes through tiny wires, block the action of neurons that are firing abnormally. It is these abnormal firing patterns that trigger the movement-related symptoms associated with Parkinson's. Shih says DBS alters not only the firing activity of neurons near the electrodes but also the activity of the axons and dendrites that project to other neurons and to other areas of the brain.

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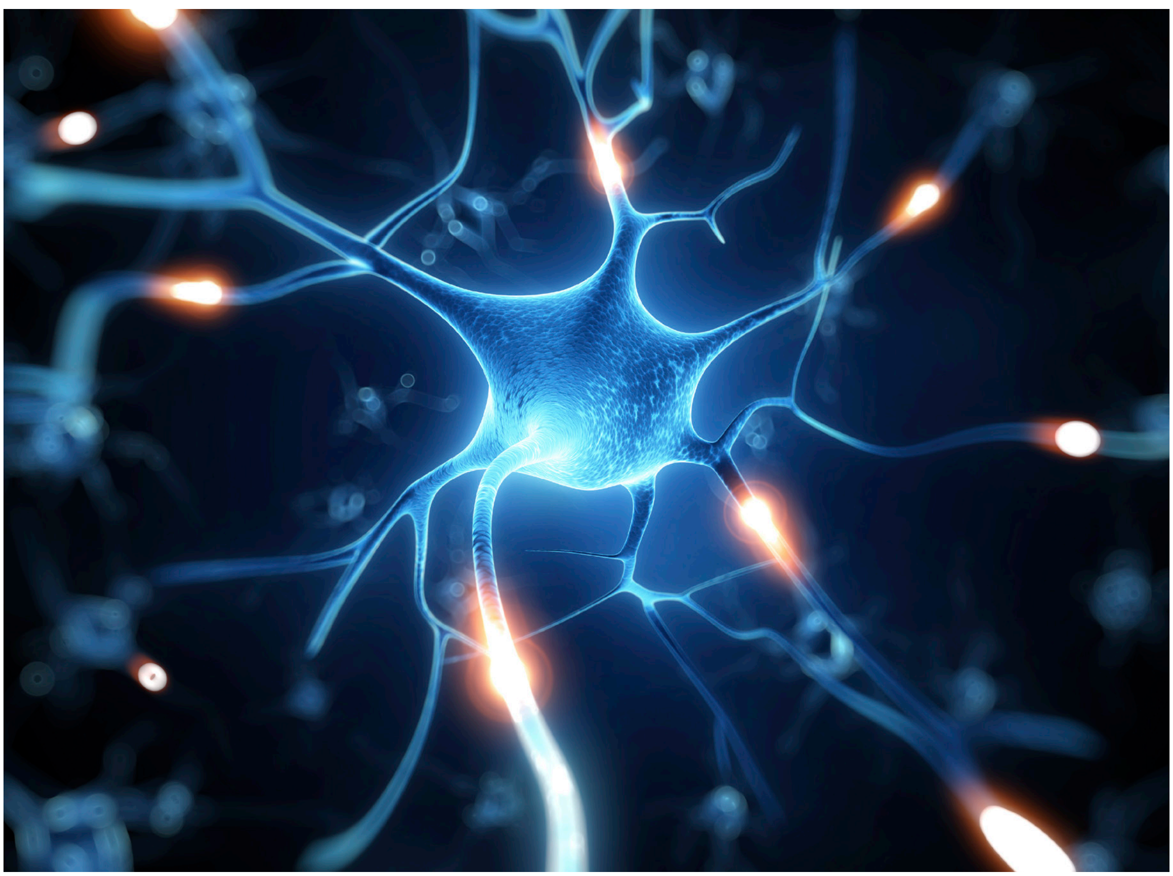

Illustration of impulses traveling along projections from the body of a nerve cell.

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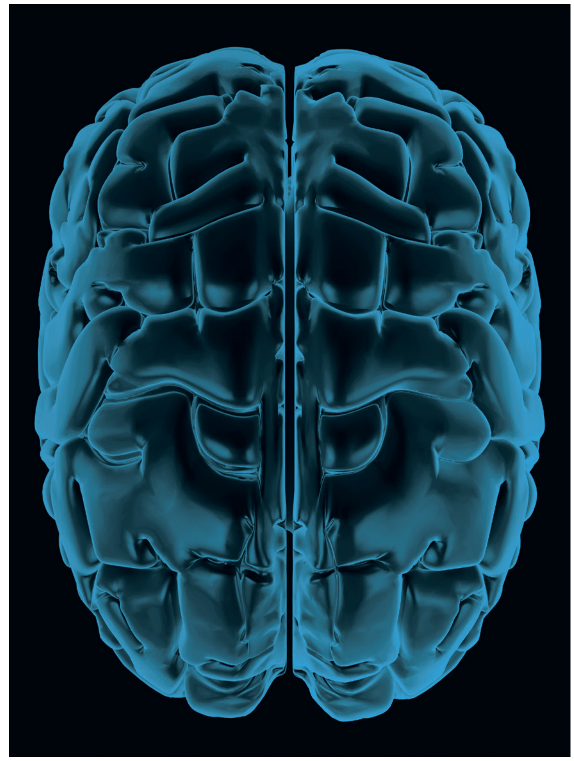
Although precisely how DBS works remains unclear, its primary target is the subthalamic nucleus (STN), a small, lens-shaped structure that sits near the brainstem. Despite its tiny size, the STN has an extensive network of projections to other basal ganglia structures involved with voluntary movement. "These areas then project into other regions of the brain, which ultimately project to the motor cortex, the brain area that primarily influences how people move," says Shih. Another target is the internal globus pallidus, a structure of the basal ganglia that helps regulate movement.

Although studies indicate that deep brain stimulation's effects on the STN and the internal globus pallidus can effectively control a range of Parkinson's symptoms, there are caveats to its benefits. DBS does not improve cognitive impairment or significant gait, balance or speech problems. Some studies indicate that targeting the internal globus pallidus might be more effective for severe involuntary movements (dyskinesias), while other studies suggest that STN stimulation may disrupt walking and balance more than stimulation of the internal globus pallidus does. In the big picture, Shih says, the degree of symptom improvement is fairly equivalent, with patients experiencing similar relief regardless of the targeted location.



Although deep brain stimulation does not stop Parkinson's from progressing as a disease, many Parkinson's patients experience a considerable reduction in their symptoms for up to a decade after undergoing the procedure.

The National Parkinson Foundation says the ideal candidate for DBS is someone who has had a Parkinson's diagnosis for at least five years and has had a good response to medication, but is starting to notice fluctuations in symptom control. Patients may experience dyskinesia in response to too much medication. When doctors seek to correct these involuntary movements by lowering the amount of medication, patients report feeling slower and stiffer. This can occur in a cyclic fashion throughout the day, leading to significant impairment.

Patients with severe, disabling tremors that do not respond to medications are also candidates for DBS, while those with balance and gait problems that lead to falls need thorough evaluation to determine whether DBS will be right for them. There is limited benefit for such symptoms as stooped posture and rapid, stuttering speech.

Long-term benefits

Unlike earlier surgical procedures, Shih says there is not much evidence that DBS causes permanent changes in the brain. Some postmortem studies show mild scars at the sites where the electrodes were placed, but it is unclear whether the scars were caused specifically by the electrical stimulation. "Most of us accept that placing a foreign object in the brain is likely to generate some mild scarring, but there is no evidence indicating that is the mechanism through which DBS acts," says Shih

Although DBS does not stop Parkinson's from progressing as a disease, and most patients must continue their medication after undergoing the procedure, Shih says many Parkinson's patients experience a considerable reduction in their symptoms for up to a decade after undergoing the DBS procedure. The most important guideline for long-term success is extensive counseling with the patient to determine whether the symptoms the patient considers most bothersome are the ones that can be effectively treated by DBS.

Resilience and the Brain

This article is part of a series on the internal and external forces that affect the brain.

The late Nelson Mandela once said: “The greatest glory in living lies not in never falling, but in rising every time we fall.” The former South African president was, of course, talking about his 18-year incarceration in South Africa’s infamous Robben Island prison. But he was also referring to the resilience needed to not only withstand that imprisonment but also to rise above that injustice to become a leading world statesman.

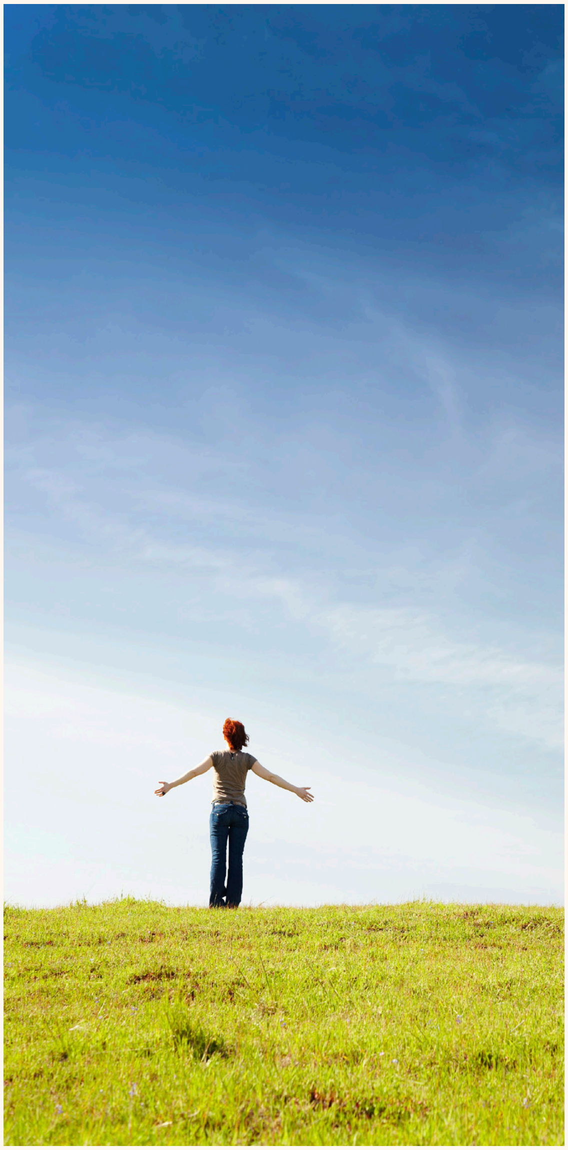
“Resilience is important because, regardless of the nature of the trauma and its impact on an individual, most of us are socially connected to and have some sort of responsibility to others,” says Monica O’Neal, an HMS clinical instructor in psychology at Cambridge Health Alliance, “and those others need us to function as best we can in relation to our role in their lives.”

Resilience is the psychological capacity to tolerate and withstand intense emotional or physical stress and to bounce back from such difficulties. It’s not that resilient people are immune to stress; they are just able manage it successfully.

Stress happens

Resilience is the psychological capacity to tolerate and withstand intense emotional or physical stress and to bounce back from such difficulties. It’s not that resilient people are immune to stress; they are just able manage it successfully. In fact, the American Psychological Association says that among those living in this country, 25 percent experience high levels of stress while 50 percent report living with moderate levels of stress. Acute stress, such as that which can result from divorce, bankruptcy, or a diagnosis of a potentially fatal disease, triggers an intense physiological response and cements an association in the brain between the specific event and fear.

When we confront a stressful situation, our eyes, ears, and other sensory organs send signals to the amygdala, an almond-shaped cluster of nerve cells located deep within the brain. The amygdala, which serves as the brain’s emotional center, interprets this sensory information and, if there seems to be danger, sends a warning signal to the hypothalamus, a region of the brain that oversees our autonomic nervous system, which regulates



respiration rate, blood pressure, heart rate, and airway dilation. Meanwhile, the sympathetic nervous system primes us to either flee from danger or stand and fight. If danger is indicated, the adrenal glands pump adrenaline into the bloodstream. A second stress response component, the hypothalamic-pituitary-adrenal axis, picks up signals that trigger the release of cortisol, the stress hormone that keeps us on alert. When the danger or stressor abates, cortisol levels fall.

For years, scientists have known that high levels of cortisol are linked to a multitude of health issues, including impaired memory and learning, lowered immune function, high blood pressure, high cholesterol, and heart disease. People who are less resilient, less able to cope with stress, may in fact have higher levels of cortisol.

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Firing neurons

There is some question as to whether resilience is hardwired in the brain. Evolutionary scientists say that our brains may be wired to learn from negative experiences, an ability that, over the millennia, would have helped humans survive as a species. Current thinking, however, says that resilience, like learning, is linked to the brain's plasticity, its ability to reorganize neural pathways as new experiences are encountered. These experiences, good or bad, cause neurons to fire. When the experience is repeated, the same neurons fire, strengthening connections among nerve cells and creating neural pathways that enable us to repeat successful behavior when responding to similar experiences in the future.

The brain's prefrontal cortex (PFC) is considered by many neuroscientists to be the single most important structure for supporting resilience. Located just behind the forehead, the PFC is in charge of our executive functions, a set of mental processes that helps us connect past experiences to present actions.

The brain's prefrontal cortex (PFC) is considered by many neuroscientists to be the single most important structure for supporting resilience. Located just behind the forehead, the PFC is in charge of our executive functions, a set of mental processes that helps us connect past experiences to present actions. Among these processes are planning, attention, judgment, and problem-solving. Our executive functions regulate our thoughts in terms of both short- and long-term decision making, which allows us to plan ahead, create strategies, and adjust our actions and reactions in the face of changing circumstances. In addition, the PFC allows us to shift our perspectives, recognize our options, and make sound choices, essential characteristics of resilience. The PFC pulls our past and present experiences together to create a type of narrative about who we are.

"Having awareness of our own personal narrative provides a more reliable compass to detect when we've veered too far off course from our 'normal' functioning," says O'Neal.

In a 2001 study, researchers at Michigan State University found that soldiers with a positive outlook in the most stressful situations were less likely to suffer health problems such as anxiety and depression. The researchers analyzed traits such as hopefulness, optimism, and ego resilience (the ability to maintain psychological well-being under difficult circumstances) in U.S. soldiers stationed in Iraq during a period of heavy fighting with insurgents. The scientists found that the more stressful the situation, the more important these resiliency traits became.

Steps to resilience

What makes one person resilient and another person less so? The American Psychological Association says several factors contribute to resilience. Among them are caring, supportive relationships; a capacity to make realistic plans and carry them out; a positive view of oneself; good communication and problem-solving skills; and the power to manage strong feelings and impulses.

"I believe that one of the biggest factors contributing to one's resilience is the ability to communicate with others," says O'Neal. "Just being able to describe the traumatic event actually provides a conduit of expression for whatever emotional state a person may be experiencing." Admitting to being overwhelmed, she adds, is a better alternative than self-medicating with alcohol or drugs.

Although the debate continues over whether resilience is hardwired in the brain, O'Neal says people who are less able to cope with stress can take steps to build resilience. The more common strategies include:

- Making strong connections and building good relationships: Communicating with family and friends can help to lessen stressful situations.
- Taking decisive action to address the event (for example, contacting the appropriate authorities or seeking medical attention): Detaching yourself from a problem may only make it worse.
- Nurturing a positive view of yourself: Having confidence in your ability to solve problems may actually help you solve problems.
- Maintaining a positive outlook: Sustaining an optimistic attitude can help you to expect good things to happen.
- Seeking help or support from available resources, such as mental health professionals or clergy

On Being a Sports Fan

The Chicago Cubs have set a record for futility. This year will mark the Cubs' sixty-seventh consecutive season since its last World Series appearance and the one hundred and fourth consecutive season since its last World Series victory. They last played in the postseason in 2008, when they lost to the Los Angeles Dodgers three games to none in the National League Division Series. And, yet, the Cubbies' faithful keep coming to Wrigley Field. The club's 2014 home-game attendance of more than 2.5 million places it in the top 11 (of 30) major league teams. So, what gives? What makes fans support the Cubs—or any other team—through thick and thin?

Richard Ginsburg, an HMS assistant clinical professor of psychology at Massachusetts General Hospital and co-director of the MGH PACES Institute of Sport Psychology, says rooting for a favorite team may be a behavior that dates back to man's earliest existence, when being part of a clan was a matter of life or death. "You identified with that clan; you protected and supported each other," he says. "I think that's being tapped into with sports teams. They represent the clan."

Like falling in love

Although there is no compelling evidence that sports fandom is hardwired in the brain, studies have linked the ecstasy experienced when following a winning team with that achieved through other social behaviors. Behaviors like love, for example.

An MRI study undertaken at Loyola University in 2014 found that levels of dopamine, norepinephrine, and adrenaline, chemicals active in the brain, increase when two people fall in love. Dopamine generates feelings of euphoria, while norepinephrine and adrenaline rev up the heart, pulse rates, and blood pressure. Sounds a bit like what happens when your favorite team is in a tight Game 7 of the NBA finals, doesn't it?

The Loyola study also linked the brain's pleasure center, a cluster of structures that respond to pleasurable stimuli and reinforce our desire for more, to the feelings we get when we fall in love—or watch a favorite team take that oh-so important game. In the study, MRI scans of the brains of love-struck participants detected increased blood flow in pleasure-center structures, including the amygdala, which controls our emotions.

Although there is no compelling evidence that sports fandom is hardwired in the brain, studies have linked the ecstasy experienced when following a winning team with that achieved through other social behaviors. Behaviors like love, for example.

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"I think there's some merit to the notion that some kind of chemical reaction is happening in the brain," says Ginsburg. "The neurochemical reactions that occur as we watch sports could be quite similar to those that occur with other kinds of behaviors in our lives."

BIRGing and CORFing

Sports psychologists often turn to two phenomena, which are part of social identity theory, to illustrate fans' commitment to their team: BIRGing and CORFing. Basking in Reflected Glory, or BIRGing, occurs when individuals associate personally with a successful team. The team's success becomes their success. Examples of BIRGing include wearing a favorite team's throw-back jersey or referring to the team as "we." The fans have contributed nothing to the team's success so they are merely basking in reflected, not earned, glory.

In contrast, sports fans can also turn to CORFing—Cutting Off Reflected Glory—when their team fares poorly or, as recently happened with the National Football League, when their team or its players are mired in controversy. Fans who CORF distance themselves from their team's failures, refusing to watch games as the season devolves.

BIRGing and, especially, CORFing, says Ginsburg, underscore the importance of each new sports season. "When your team fails," he says, "you give up on them—CORFing—and can then move on to the next season." Hopefully, a better one.

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Joseph B. Martin, MD, PhD
Edward F. Rover

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Editor: Ann Marie Menting

Freelance Writer: Scott Edwards

Design: Gilbert Design Associates, Inc.

In collaboration with: Michael E. Greenberg, Nathan Pusey Professor of Neurobiology and Chair, HMS Department of Neurobiology

Harvard Mahoney Neuroscience Institute
Harvard Medical School
107 Avenue Louis Pasteur
Suite 111
Boston, MA 02115

www.hms.harvard.edu/hmni
hmni@hms.harvard.edu

CORRESPONDENCE/CIRCULATION

Harvard Medical School
Gordon Hall
25 Shattuck Street, Room 001
Boston, MA 02115