Everything Jersey

THE SEEKERS: THE MIND'S 'I'

Part 1 of 5: What is it that makes you think you're you?

Sunday, December 01, 2002

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NEW YORK -- Maps are the tools of dreamers. A map gives substance to possibility, truth to discovery. In the 16th and 17th centuries, cartographers were called "world describers." In the 21st century, it is neuroscientists who are pushing back the boundaries, attempting to describe that final terra incognita, the human mind.

In 1637 the mind was front and center when Descartes announced, "I think, therefore I am." Having proven his own existence, the French philosopher then asked himself the mother of all follow-up questions: "What is this 'I' that I know?"

Nearly four centuries after Descartes essentially threw in the philosophical towel, Todd Feinberg, a neurologist at Beth Israel Medical Center in New York City, and Julian Keenan, an experimental psychologist at Montclair State University, believe they are close to mapping the place in the brain where the sense of self is formed.

Feinberg, author of "Altered Egos: How the Brain Creates the Self," treats patients who have neurological damage, studying how their injuries have robbed them of the key ingredients of their identity.

For many of his patients, stroke, disease and physical trauma -- especially in the right hemisphere of their brains -- have resulted in a kind of self-alienation. They are people whose brains have lost their way.

Keenan, author of the soon-to-be-released "The Face in the Mirror," is researching those same ingredients through experiments that involve magnetic stimulation of the brains of healthy subjects, testing for the thing that he believes makes us uniquely human: self-recognition.

Among all the species on the face of the earth, human beings alone inquire about who they are. Feinberg and Keenan are among a small band of scientists reaching through the mists of memory and emotion to explain how this could be.

THE ALIEN HAND

Todd Feinberg hunches in his chair as his theory of the fractured self is played out in front of him in a simple game of cards. An elderly couple sitting across from him are playing war, in which two players simultaneously pick up cards from their own halves of the deck and place the cards next to one another. Whoever has the card with the higher face value wins the round.

Sylvia is moving the game along at a clip, and it's clear why. Every time she picks up a card from her own pile with her left hand, she is compelled to pick up a card from her husband's pile with her right hand.

Feinberg, a psychiatrist as well as a neurologist, is fascinated. Quite literally, Sylvia's right hand doesn't know what the left hand is doing. Only occasionally, and seemingly unconsciously, does Sylvia (not her real name) realize that her right hand is meddling with the game, and when she does, she places the hand between her knees and squeezes it to try to keep it from misbehaving.

The 72-year-old woman, who owns an antique store in New Jersey with her husband, suffers from alien hand syndrome, a rare neurological condition. A stroke several months ago damaged Sylvia's corpus callosum, a broad band of 200 million fibers that bind together the left and right hemispheres of the brain. Signals from the left hemisphere, which would normally inhibit the actions of Sylvia's right hand, are not getting through to the other side of the brain. The result is that her right hand seems to have a life of its own.

When she speaks to her husband on the phone from her room in the Center for Head Injuries at JFK Johnson Rehabilitation Institute in Edison, she cradles the receiver with her left hand, but her right hand frequently reaches out and disconnects the call.

When she eats with her left hand, her right hand will wipe the table with an imaginary cloth.

And when she plays checkers, she moves her own piece with her left hand, and then her opponent's with her right.

Sylvia, for all intents and purposes, is a woman of two minds. Which is why, says Feinberg, she not only has a damaged brain, she has a fractured self.

"Alien hand syndrome tells us a lot about brain unity," says the 51-year-old doctor. "It tells us that there is no consciousness or mind that does not require cerebral integration. If you destroy or damage the corpus callosum, there are times at which the brain can act as though it was

Only in the 20th century did the brain become the primary focus in the search for the self. The ancient Egyptians thought the self, or the mind, was located in the bowels. The Sumerians and Assyrians thought it was in the liver, Aristotle the heart.

Descartes thought they were all wrong. The mind and the body, he wrote, were two separate entities. The body was a physical organ, a complex machine that walks, eats and sleeps, and the mind was a disembodied spirit, intangible and unobservable but altogether real.

In 1949, British philosopher Gilbert Ryle said Descartes' dualism was preposterous. An independent, invisible secret agent inhabiting the body? That would mean there was a "ghost in the machine." Ryle rejected the idea of two separate entities. There was, he contended, no intangible self, no "homunculus," or miniature man, directing a person's thoughts and actions from the inside. Instead, a person simply was his thoughts and actions, and the world was processed entirely by the gelatinous gray and white matter inside our skulls.

The mystical mind was out, the hard-wired brain was in.

SHIFTING LANDSCAPE

Mapping the brain, of course, has not been an easy task. A dense tapestry threaded by archipelagoes of nerve cells, the brain consists of billions of neurons and trillions of synapses. It is the most complex object on the planet. The heart pumps blood, the lungs ingest oxygen, the stomach absorbs nutrients, but the functions of the brain are manifold. It monitors the body's basic processes, coordinates physical movement, perceives, thinks, acts and feels. It is an executive branch of government that ceaselessly plans, reacts and interacts with the organic world around it.

It takes millions of neurons firing in sequence to create the simplest thought, and in the same way the Greek philosopher Heraclitus believed one never steps into the same river twice, we cannot have the same thought twice. Every sensation, every idea, every action creates a unique firing pattern, and each firing pattern creates a wave of neuronal activity that reacts to the one that came before it. At every moment, the landscape of the brain is being redrawn.

The idea that this puzzle of brain activity could be assembled into a single, subjective consciousness has perplexed Feinberg for most of his life. How does a 3-pound lump of matter

become a "me"?

"The first thing that I remember discovering in life was that I had a brain," says Feinberg, founder and chief of the Yarmon Neurobehavior & Alzheimer's Disease Center at New York City's Beth Israel Medical Center. "I couldn't have been more than 6 years old, and one day I said to myself: 'I have thoughts and I have experiences. I have consciousness. But where are they? Where are they located? How come I can't see them? How come they can't be touched and measured and weighed?' And I just could not believe that. Ever since, I've been obsessed with the mind."

In truth, the life of any one mind is irremediably closed, colored by experiences and bounded by the uniqueness of individual perspective. "The mind is its own place," wrote Ryle, "and in his inner life each of us lives the life of a ghostly Robinson Crusoe ... blind and deaf to the workings of one another's minds and inoperative upon them."

"There is no way to find out if your experience of the color red, for instance, is like my experience of the color red," says Martha Farah, director of the University of Pennsylvania's Center for Cognitive Neuroscience. "But if you define consciousness as mental content -- the information contained in thoughts that is reportable by the person, and which they can reflect on and talk about -- then, in that sense, consciousness is a valid subject of scientific study."

It is the content of consciousness that particularly interests Feinberg. The son of two psychologists, he was reading Freud in the second grade and by high school had steeped himself in abnormal psychology. After graduating from the University of Pennsylvania summa cum laude and receiving his medical degree from Mount Sinai School of Medicine in New York, Feinberg took on a dual residency in psychiatry and neurology, becoming an expert on both sides of the Cartesian coin -- the mind and the body.

Like the best scientists, Feinberg is a tightrope walker, searching for purchase on the subtlest threads of evidence, trusting only his sense of imbalance to tell him how much farther he has to go. Every day, he tests the wire.

"When I got out of the shower this morning, I stubbed my toe and it hurt and it hurt," says Feinberg, who lives with his wife and teenage son in Tenafly. (A daughter studies psychology at Syracuse University.) "And I said to myself: 'Boy, if that isn't mysterious. Why and how am I in pain if those neurons that are telling me I'm in pain aren't themselves throbbing in pain?'

"Where is that pain? When I stubbed my toe I didn't grab my head in pain. I grabbed my toe. If I had an 'autocerebroscope' and I could look through it and observe my own brain, I might see neurons firing in patterns, but I'll never find that pain. I can't touch it. I can't see it. I can only experience it.

"And that, in a nutshell, is what is so mysterious about consciousness."

BILLION-PIECE PUZZLE

Subjective experience can't be seen or heard or touched. It simply is. Feinberg calls this the "transparency problem."

There is a second aspect to self-awareness that deepens the mystery, the "binding problem," which is: How do billions of different neurons come together to form a single unified self, and if we know where the neurons are located, why can't we find the self?

It's a bit like looking for Beethoven's Fifth Symphony in the sheet music. The score includes all the notes played by the violins, the cellos, the timpani and so on. But where is the music, this thing called "Beethoven's Fifth Symphony"?

For Feinberg, solving the problem of the unity of consciousness is like building a cathedral from a billion blades of grass. "If you're a really obsessional person like I am," he says, "then you can't give up. You don't ever say it can't be understood. So you just don't stop."

Feinberg's office at Beth Israel is a testament to the neurologist's professional and personal fixation. Framed brain scans adorn his wall like family photographs. Feinberg points to each of them in turn: "This is an interesting one because it's abnormal. That's a normal one. That's an abnormal one." Ever the teacher, he asks his visitor about the picture just over his right shoulder:

"Can you tell what's wrong with this one?" The entire corpus callosum is missing. "Amazing," he says, "isn't it?"

The secrets of the self, Feinberg believes, lie in the brains of his patients.

"As slicing an apple reveals its core, the neurological lesion or damage opens a door into the inner self," he writes in his book. "It provides an opportunity to examine the physical structure of the self and to see how the self changes and adapts in response to the damaged brain."

There are many ways to define consciousness, including the act of simple perception. Self-awareness and the ability to recognize that other people have self-awareness represent the highest order of consciousness.

"Everything, in the last analysis -- every feeling, every thought, every memory, every state of mind -- has to be represented by a brain state," says Gordon Gallup, psychologist at the State University of New York at Albany and one of the first to study self-recognition in primates. "These things aren't generated in a vacuum."

Many of Feinberg's patients are stroke victims, and many, if not most, have suffered damage to the right side of their brains. Because the right hemisphere affects the left side of the body (and vice versa), these patients have problems with their left limbs, as well as vision and general movement on the left side.

Sylvia is an unusual case. She was examined by Feinberg at the JFK Johnson Rehabilitation Institute's Center for Head Injuries in late September as a guest of Joseph Giacino, the center's associate director of neuropsychology, who is a frequent collaborator with Feinberg. Sylvia is Giacino's patient. Both doctors agree Sylvia has suffered an anterior cerebral artery stroke in the left hemisphere of her brain, which has led to damage on the left side of the corpus callosum, as well as in supplementary motor areas.

Basically, Sylvia's brain was deprived of oxygen and a small bundle of cells between the two hemispheres liquefied, then hardened into a scar the size of a half-dollar.

In many of the alien hand cases Feinberg has seen, the limbs act in violent opposition. (Unlike Sylvia's case, patients who have damage only to the corpus callosum will always have left-hand alien hand syndrome.) When one of Feinberg's patients tried to button his shirt with his right hand, his left hand unbuttoned it. When he picked up a forkful of food with his right hand, the left hand knocked it away. Another patient reported that her left hand tried to strangle her while she slept.

"The thing that grabs one's attention here," says Feinberg excitedly, "is the fact that you have two hemispheres in one person with competing and conflicting attentions, and that highlights the incredible unification in normal intact individuals. ... The sense of the self is the sense of a unified self, of personhood."

Some cognitive scientists believe this fact makes it impossible to localize consciousness to one area, or even several areas, of the brain.

"The frontal poles of the brain separate humans from all other living things," says neuropsychologist Mark Wheeler of Temple University. "But that is not going to be the whole story. You don't lose consciousness by losing a bit of brain tissue. ... There are physical correlates to everything. Questions like 'How does a brain state become a mental state' I don't know how to answer. Neuroscience has done an incredible job in the last few years; the philosophy of mind hasn't moved much in 300."

DETACHMENT

In his filing cabinets, Feinberg has hundreds of scans of patients whose sense of personhood was shattered by stroke or disease. Atop the cabinet are scores of videos of many of those patients going back 18 years. In one, an elderly, hearing-impaired woman who knew sign language and could read lips looked at her reflection in a mirror. Feinberg asked her what she was doing, and she said she was communicating in the mirror with someone else, someone who was very much like her and attended the same grade school but was nonetheless a stranger.

Talking about this person in the mirror, the woman said: "She's not a very good lip reader. I had to

talk mostly in sign language for her, to make her understand. ... She's not that bright. I hate to say that. ...

"She's a nice person. But one thing about her ... I see her every day through a mirror, and that's the only place I can see her. When she sees me through the mirror, she looks a little, then she

Feinberg's diagnosis was a delusional misidentification problem known as "Capgras syndrome for her mirror image," caused by atrophy in the right temperoparietal region of the brain. Except for misidentifying her own reflection, the woman was perfectly normal.

Some of Feinberg's patients suffer from asomatognosia, in which they deny or misidentify a part of their own body after it has been paralyzed by stroke. In all of the cases Feinberg has seen, the damage was to the patients' right hemisphere, causing them to attribute ownership of their left arm to another person -- a relative, a stranger -- or even a pet.

Some patients try to throw the disowned arm out of bed. Others, trying to acclimate, create stories about the arm, give it nicknames such as "Toby" or "Silly Billy," or simply refer to it as "a canary claw," "a sack of coal" or "dead wood."

Feinberg's research has shown a peculiarly gender-specific phenomenon associated with asomatognosia. Women frequently will mistake their left arms for their husbands' arms. Men will frequently mistake their left arms for the arms of their mothers-in-law.

There is no cure for most of these patients, but over weeks and sometimes years, their symptoms often diminish and even disappear -- a testament to the resourcefulness, as well as recuperative ability, of the damaged brain.

Sylvia, after just a few months, already has begun to recognize and gain more control over the actions of her right hand.

Feinberg believes that the sense of identity is probably a mixture -- what he calls a "nested hierarchy" -- of coordinated functions arising out of several areas of the brain, but he believes, too, that the right hemisphere is dominant as the source of the self.

Julian Keenan's belief is stronger, and more specific. The right hemisphere isn't simply dominant in the formation of self-awareness, he says, it is essential.

"I think there actually is a center" of the self, says Keenan as he leans back in a chair in his office at Montclair State University. "There are definite neural correlates of higher-order consciousness that, if you mark them out, the person is no longer conscious, no longer capable of self-awareness."

Just a tenth of an inch beneath the furrowed ridges of gray matter that cover the right front side of the brain, he contends, is a layer of tangled cell tissue that makes us uniquely human.

While acknowledging there may be other similarly minuscule areas of the brain that contribute to consciousness, the 32-year-old experimental cognitive psychologist has come to the conclusion that the right prefrontal cortex -- located just above the right eye -- is the primary source of self-awareness.

A TOUCH OF PRINCESS DI

Two years ago, while conducting postdoctoral research in behavioral neurology at Harvard Medical School, Keenan created an unusual experiment to test for "self-face recognition," which he regards as the hallmark of higher consciousness.

"What we know, as far as self-face recognition is concerned, is that it's reserved for a very few species," says Keenan, who lives with his wife, Ilene, in Jersey City. "Only chimpanzees, orangutans and humans have the ability to recognize an image as their own. So what we wanted to do was see where in the brain that takes place."

Volunteering as test subjects were five people about to undergo brain surgery at Boston's Beth Israel Deaconess Medical Center for severe epilepsy. During the presurgical evaluation of each

patient, the two hemispheres of the brain were anesthetized, one at a time, while the patient stayed conscious and alert. After each hemisphere was numbed, Keenan and his colleagues showed the person a photograph with a morphed image blending the patient's face with that of a famous person's -- Marilyn Monroe or Princess Diana for the women, Bill Clinton or Albert Einstein for the men. After the testing, each patient was presented with two conventional photos, one of himself or herself and one of the famous person. They were asked which was the one they remembered seeing under anesthesia.

The results were startling. When the right hemisphere was anesthetized, four of the five recollected seeing only the famous person. With the left hemisphere numbed, all five patients remembered the morphed picture as a photo of themselves alone.

"We really saw that the right hemisphere was the big player in self-recognition," says Keenan, "and in particular the right prefrontal cortex." His conclusion: That is where the self resides.

For Keenan, thinking about thinking is a deeply personal preoccupation. It's easy to imagine what a scan of the young psychologist's brain would have looked like: storm clouds of electrical activity roiling through the right hemisphere, firing up neurons as if they were lights on the Rockefeller Center Christmas tree.

"It started when I was 15 when I read 'Gödel, Escher, Bach' by Douglas Hofstadter," says Keenan, referring to the 1979 best seller about mathematics, art and music, "and that book has just always stayed with me -- all those self-referential systems. We all think about our own thoughts. We all think about, 'Am I the only person on this planet and everyone else is just a robot?' We all have these sorts of ideas about our own thinking, about the little voice in our head. ... I guess I've always thought that everyone thinks like that."

Keenan is an abstract painter and a musician and likes to speak in visual terms. In considering the brain, he cites an article by John Updike about baseball Hall of Famer Ted Williams on the eve of Williams' retirement.

"Updike described Williams, who at that point was old and injured, as looking like a Calder mobile with one of its threads cut. I thought that was the most beautiful description. Everything went off balance just a little bit. And as I read that, I thought: What a great description for the brain. There are these separate sorts of units and they're all in balance, and even though they may look

Every year Keenan asks students in his Introduction to Physiological Psychology course to create a mobile with the brain as the governing theme, and he hangs the best ones in his office. As he speaks, a mobile of a neuron, made out of multicolored pipe cleaners, dangles delicately overhead.

PEEKING AT THE DARK

While Keenan and Feinberg are traditional materialists, believing that the mind is nothing more than brain functions, others, like Daniel Dennett, a cognitive scientist at Tufts University, believe the mind is nothing at all -- that mental states don't arise from neural states, they are neural states. Dennett once declared about consciousness: "It's like fame. It doesn't exist except in the eye of the beholder."

Colin McGinn, philosopher of mind at Rutgers University, also believes the self is elusive, but not because it is nonexistent; because it is fundamentally unknowable. "We're trapped inside ourselves, inside our own language," says McGinn. "For that reason, trying to describe the contents of our consciousness with the same tools, the same words is inadequate."

William James, the pioneering 19th-century philosopher and psychologist (and brother of novelist Henry James), said that trying to describe introspection was like "trying to turn up the gas (light) quickly enough to see how the darkness looks."

Keenan, however, believes the science of consciousness can transcend linguistic limitations.

In a new series of experiments at Montclair State, he is using a device called a transcranial magnetic stimulator to measure how active each hemisphere of the brain is in tasks involving self-recognition. When gently placed against the skull, the stimulator -- which looks oddly like a

thick, metal Mardi Gras mask -- creates a magnetic field that painlessly deactivates a specific area of the brain for a moment as brief as a hundred-thousandth of a second. When the device is held over the area of the right prefrontal cortex -- the area Keenan believes is the source of self-recognition -- subjects routinely take a fraction of a second longer than normal to recognize their face on the computer screen. When the stimulator is held over the left frontal region, nothing happens.

"Again and again, what we're seeing is that the processes of self-evaluation are preferentially engaged in the right hemisphere," says Keenan. "And it is that ability to recognize one's own face that appears to be a hallmark of consciousness. To know that our own face is ours inevitably requires knowledge of the self. Without self-knowledge, it would be seemingly impossible to recognize who we are."

Farah, the Penn neuroscientist, whose primary research is in the neural correlates of cognition, believes self-recognition studies are helping to advance the scientific study of the mind. "A lot of the work on sense of self and the brain is pretty flaky," she says, "but Keenan's and Feinberg's work is credible. Keenan has found distinctive patterns of brain activity that correlate with processing one's own face compared to other people's, and Feinberg finds that certain brain lesions disrupt a person's ability to recognize their own face or arms as belonging to them. This tells us that one's sense of physical self is the result of specific brain systems."

Keenan claims to be obsessed by his work, and a sleeping bag wedged atop the bookcase in his office attests to that. "There's always so much more to know," he says. "There's always just another level of understanding. You think you have a clue, and then you find out you have no clue, and it goes on and on and on. It's never-ending. You can never know enough."

Still, Keenan believes that in the next 10 years he will know enough to have a new map of the brain with more precise coordinates of the self. Describing subjective experience may forever be elusive; describing what it is that makes us most human, he says, is not.

That's all Feinberg is looking to do, too, and he believes the search is profoundly important: "You could argue that aside from intelligence, the sense of the self is probably the greatest human achievement. Without that sense of being a being, where would we be?"

TOMORROW: The science of aging.