

Local news

Adlesse

- [Greece risks meltdown after bailout vote bombshell](#)
- [Greek vote brings uncertainty back to Wall Street](#)

Advertise on NYTimes.com

PROFILES IN SCIENCE | MICHAEL S. GAZZANIGA

Decoding the Brain's Cacophony



Jim Wilson/The New York Times

Michael Gazzaniga: An interview with the neuroscientist and professor of psychology known for his studies, and stories, about the brain's split personality.

By BENEDICT CAREY

Published: October 31, 2011

ST. HELENA, Calif. — The scientists exchanged one last look and held their breath.

Profiles in Science

Michael S. Gazzaniga

This is the fourth in an occasional series of articles and videos about leaders in science.

Previous Articles in the Series »

Related

Midnight Labs and Martini Time (November 1, 2011)

RSS Feed

Get Science News From The New York Times »

Enlarge This Image

Everything was ready. The electrode was in place, threaded between the two hemispheres of a living cat's brain; the instruments were tuned to pick up the chatter passing from one half to the other. The only thing left was to listen for that electronic whisper, the brain's own internal code.

The amplifier hissed — the three scientists expectantly leaning closer — and out it came, loud and clear.

"We all live in a yellow submarine, yellow submarine, yellow submarine"

"The Beatles' song! We somehow picked up the frequency of a radio station," recalled Michael S. Gazzaniga, chuckling at the 45-year-old memory. "The brain's secret code. Yeah, right!"

Dr. Gazzaniga, 71, now a professor of psychology at the

- RECOMMEND
- TWITTER
- LINKEDIN
- COMMENTS (59)
- E-MAIL
- PRINT
- REPRINTS
- SHARE



Latest in My Network

What's This?

- Tom Marker** RECOMMENDED
Push for 'Personhood' Amendments Is New Tack in Abortion Fight
- Ronald St Pierre** RECOMMENDED
Caitlin R. Kiernan, Geoff Ryman and Tim Powers Tales - Review
- Susan Corral** RECOMMENDED
Squeezed Out in India, Students Turn to United States

POPULAR NOW

Did You Hear the One About the Bankers?

Ads by Google

what's this?

Mental Health Psychology

Mental Health Psychology-focused Master Degree in Applied Psychology EducationDegreeSource.com/Online_MS

Active Phosphodiesterases

High Activity and Purity BioBlitz MegaSale Nov. 15-17, 2011 www.signalchem.com

Psychotherapy in Tokyo

US-licensed therapist in Roppongi Individuals, couples and families www.japantherapist.net

VIA 1st DualCore Mini-ITX

EPIA-M900 wi Nano X2 CPU. Up to 8GB DDR3. Dual-channel 24-bit LVDS. www.viatech.co.jp

LLM in U.S. Law

Study in San Francisco at the University of California. www.uchastings.edu/llm

Biomarker Services

Gene Expression Biomarker Discovery Assay Development + Testing Service www.genebiomarkers.com

Advertise on NYTimes.com

TicketWatch: Theater Offers by E-Mail



Sign up for ticket offers from Broadway shows and other advertisers.

tonsilva@mac.com Sign Up

Change E-mail Address | Privacy Policy

MOST E-MAILED

RECOMMENDED FOR YOU

54 articles in the past month

tonyinosaka All Recommendations



1. Joyce Clifford, Who Pushed for 'Primary Nursing' Approach, Dies at 76

2. High Fatality Rate Found for Low-Cost Buses



Jim Wilson/The New York Times

Michael S. Gazzaniga is a psychology professor at the University of California, Santa Barbara.

[Enlarge This Image](#)



Michael Gazzaniga, in striped shirt, with his family in 1945.

[Enlarge This Image](#)



Dr. Gazzaniga as a student at Caltech in 1963.

[Enlarge This Image](#)

[University of California, Santa Barbara](#), is best known for a dazzling series of studies that revealed the brain's split personality, the division of labor between its left and right hemispheres. But he is perhaps next best known for telling stories, many of them about blown experiments, dumb questions and other blunders during his nearly half-century career at the top of his field.

Now, in lectures and a new book, he is spelling out another kind of cautionary tale — a serious one, about the uses of neuroscience in society, particularly in the courtroom.

Brain science “will eventually begin to influence how the public views justice and responsibility,” Dr. Gazzaniga said at a recent conference here sponsored by the Edge Foundation.

And there is no guarantee, he added, that its influence will be a good one.

For one thing, brain-scanning technology is not ready for prime time in the legal system; it provides less information than people presume.

For another, new knowledge about neural processes is raising important questions about human responsibility. Scientists now know that the brain runs largely on autopilot; it acts first and asks questions later, often explaining behavior after the fact. So if much of behavior is automatic, then how responsible are people for their actions?

Who's driving this submarine, anyway?

In his new book, “Who's in Charge? Free Will and the Science of the Brain,” being published this month by Ecco/HarperCollins, Dr. Gazzaniga (pronounced ga-ZAHN-a-ga) argues that the answer is hidden in plain sight. It's a matter of knowing where to look.

The Split Brain

He began thinking seriously about the nature of responsibility only after many years of goofing off.

Mike Gazzaniga grew up in Glendale, Calif., exploring the open country east of Los Angeles and running occasional experiments in his garage, often with the help of his father, a prominent surgeon. It was fun; the experiments were real attempts to understand biochemistry; and even after joining the Alpha Delta Phi fraternity at Dartmouth (inspiration for the movie “Animal House”), he made time between parties and pranks to track who was doing what in his chosen field, brain science.

In particular, he began to follow studies at the [California Institute of Technology](#) suggesting that in animals, developing nerve cells are coded to congregate in specific areas in the brain. This work was captivating for two reasons.

First, it seemed to contradict common wisdom at the time,



3. [U.N. Says 7 Billion Now Share the World](#)

4. [Cooper Union Looks at Charging Tuition](#)



5. [LINK BY LINK A Store of Images, From a Time When 'Cut and Paste' Meant Just That](#)



6. [DESIGN The Power, or Folly, of a Product's Name](#)

7. [SPECIAL REPORT: CENTRAL EUROPEAN BUSINESS In Romania, Start-Ups Gain Strength](#)



8. [OP-ED COLUMNIST Addicted to Exercise?](#)

9. [EDITORIAL Falling Crime, Teeming Prisons](#)



10. [THE TEXAS TRIBUNE State Finds a Way to Make Weatherization Work](#)

PRESENTED BY

[Go to Your Recommendations »](#)
[What's This?](#) | [Don't Show](#)



The specialized art of the appraisal

ALSO IN BUSINESS »

[Take advantage of tax breaks now](#)
[What to ask a prospective wealth manager](#)

nytimes.com

BUSINESS

ADVERTISEMENTS



What's a "Hi-Fi House"? Here's the answer - [NYTimes.com/Style](#)

News and commentary with a **global voice.**

VISIT THE **GLOBAL EDITION** ▶

[The New York Times](#) | [International Herald Tribune](#) [global.nytimes.com](#)

Ads by Google

[what's this?](#)

[Brain signal research](#)

VTT develops biosignal processing methods for brain monitoring.
[www.vtt.fi](#)

[Study in Australia](#)

Have you considered having a world- class education? Find out more!
[www.StudiesInAustralia.com](#)

[DA VOLTERRA, Paris-France](#)

Pioneering Treatments Fighting Resistance to Antibiotics
[www.davolterra.com](#)



LEFT BRAIN, RIGHT BRAIN Dr. Gazzaniga with his colleagues John Sidtis and Jeffrey Holtzman, in lab coats, in the van they used at Dartmouth for studying the brain's hemispheric division of labor.

which held that specific brain functions like memory were widely — and uniformly — distributed in the brain, not concentrated in discrete regions.

Second, his girlfriend was due to take a summer job right there near Caltech.

He decided to write a letter to the director of the program, the eminent neurobiologist Roger Wolcott Sperry (emphasizing reason No. 1). Could Dr. Sperry use a summer intern? “He said sure,” Dr. Gazzaniga said. “I always tell students, ‘Go ahead and write directly to the person you want to study with; you just never know.’”

At Caltech that summer after his junior year, he glimpsed his future. He learned about so-called split-brain patients, people with severe epilepsy who had surgery cutting the connections between their left and right hemispheres. The surgery drastically reduced seizures but seemed to leave people otherwise unaffected.

Back at Dartmouth, he couldn't stop thinking about it: Totally unaffected? Combing the literature, he found that the best attempt to detect an effect had found no changes in thinking or perception among 26 patients who had had the

surgery at the University of Rochester.

Could that be possible? Mr. Gazzaniga was so eager to test the patients' perceptions himself that he wrote another letter, this time to the surgeon — and got permission to do so.

“It's spring break, I get all my gear together, I get all the way over there, and the guy changes his mind,” Dr. Gazzaniga said. “Like, ‘Hey, buddy, go home!’”

After graduating, he headed straight for Caltech.

“It wasn't just ambition, it was something else — he was gutsy,” said Mitch Glickstein, who was in Dr. Sperry's lab at the time and is completing a book, “Neuroscience: A Historical Introduction.” “Here's this junior in college, he knows all about the split-brain patients, and he's ready to do original research. At 20 years old.”

Caltech in those days was like a frat house for [Nobel Prize](#) contenders. Here's Richard Feynman, the physicist, parking himself in the lab unannounced and making wisecracks about the experiments. There's Dr. Sperry, annoyed, wondering how to one-up Dr. Feynman. One afternoon Dr. Sperry's young student scrambled out into the hallway on all fours after an escaped lab animal and nearly kneecapped Linus Pauling, the eminent chemist. (“Why don't you try anesthetizing a bowl of jelly instead?” Dr. Pauling remarked icily.)

And then there were the experiments, each one a snapshot into the dark box of the brain. In the early 1960s, Dr. Gazzaniga, then a graduate student, teamed with Dr. Sperry and Dr. Joseph Bogen, a brain surgeon, to publish a string of reports that dramatically demonstrated hemispheric specialization in humans.

The researchers devised a way to flash a picture of a bicycle to the right hemisphere alone. When split-brain patients were asked what they saw, they replied, “Nothing”: Because of the severed connection, the left hemisphere, where language is centered, got no visual input and no information from the right hemisphere. So the right hemisphere — which “saw” the bike — had no language to name it.

But here was the kicker: The right hemisphere could direct the hand it controls to draw the

[Schizophrenia](#)

Unique Mental Health Care Treatment Hope for Mental Health Issues
www.earthhouse.org

[Saybrook Graduate School](#)

Earn your MA or PhD at a distance Humanistic Psychology & Org Systems
www.saybrook.edu

[レジストリエラーを清掃](#)

PCのエラー修復やレジストリ最適化！ 無料ダウンロード
100%の満足を保証
Systweak.com/JP

[Advertise on NYTimes.com](#)

Ads by Google

[what's this?](#)

[S&T + R&D Evaluation](#)

Experts in bibliometrics &
R&D - S&T program evaluation
www.science-metrix.com

bicycle.

In other studies, the three scientists showed that the right hemisphere could also identify objects by touch, correctly selecting, say, a toothbrush or a spoon by feel after seeing the image of one.

The implications were soon clear. The left hemisphere was the intellectual, the wordsmith; it could be severed from the right without loss of I.Q. The right side was the artist, the visual-spatial expert.

The findings demolished the theory that specific functions were widely and uniformly supported in the brain. It also put "left brain/right brain" into the common language, as shorthand for types of skills and types of people. Still, in a field defined by incremental, often arcane advances, the Caltech team had achieved a moon shot.

Dr. Gazzaniga, now all of 25, could write his own ticket. He soon had a grant for a study to record the electronic chatter between the two hemispheres in the brain of a cat.

The Interpreter

The Beatles song that surged through the receiver in that experiment provided Dr. Gazzaniga with something almost as valuable as insight: a good story. Yet it also served as a rude reminder that he and his colleagues were missing something important in their assumptions about the brain.

"The question, ultimately, was why?" Dr. Gazzaniga said. "Why, if we have these separate systems, is it that the brain has a sense of unity?"

Even as he built his early triumph into a career, moving from Caltech to U.C. Santa Barbara and eventually to Dartmouth, with several stops along the way, the same question hung in the air, without a satisfactory answer. In the late 1970s, with the psychologist and linguist George A. Miller, he founded the field of cognitive neuroscience, a marriage of psychology and biology aimed at solving just such puzzles.

It didn't happen, at least not quickly. In the decades to follow, brain scientists found that the left brain-right brain split is only the most obvious division of labor; in fact, the brain contains a swarm of specialized modules, each performing a special skill — calculating a distance, parsing a voice tone — and all of them running at the same time, communicating in widely distributed networks, often across hemispheres.

In short, the brain sustains a sense of unity not just in the presence of its left and right copilots. It does so amid a cacophony of competing voices, the neural equivalent of open outcry at the Chicago Board of Trade.

How?

It turned out, yet again, that people who'd had the split-brain surgery helped provide an answer. Dr. Gazzaniga, now at Dartmouth, performed more of his signature experiments — this time with an added twist. In one study, for instance, he and Joseph LeDoux, then a graduate student, showed a patient two pictures: The man's left hemisphere saw a chicken claw; his right saw a snow scene. Afterward, the man chose the most appropriate matches from an array of pictures visible to both hemispheres. He chose a chicken to go with the claw, and a shovel to go with the snow. So far, so good.

But then Dr. Gazzaniga asked him why he chose those items — and struck gold. The man had a ready answer for one choice: The chicken goes with the claw. His left hemisphere had seen the claw, after all. Yet it had not seen the picture of the snow, only the shovel. Looking down at the picture of the shovel, the man said, "And you need a shovel to clean out the chicken shed."

The left hemisphere was just concocting an explanation, Dr. Gazzaniga said. In studies in the 1980s and '90s, he and others showed that the pattern was consistent: The left

hemisphere takes what information it has and delivers a coherent tale to conscious awareness. It happens continually in daily life, and most everyone has caught himself or herself in the act — overhearing a fragment of gossip, for instance, and filling in the blanks with assumptions.

The brain's cacophony of competing voices feels coherent because some module or network somewhere in the left hemisphere is providing a running narration. "It only took me 25 years to ask the right question to figure it out," Dr. Gazzaniga said.

"One of the toughest things in any science, but especially in neuroscience, is to weed out the ideas that are really pleasing but unencumbered by truth," said Thomas Carew, former president of the Society for Neuroscience and dean of the New York University School of Arts and Sciences. "Mike Gazzaniga is one of those in the field who's been able to do that."

Dr. Gazzaniga decided to call the left-brain narrating system "the interpreter." The storyteller found the storyteller.

Emergent Properties

Knowing the breed well, he also understood its power. The interpreter creates the illusion of a meaningful script, as well as a coherent self. Working on the fly, it furiously reconstructs not only what happened but why, inserting motives here, intentions there — based on limited, sometimes flawed information.

One implication of this is a familiar staple of psychotherapy and literature: We are not who we think we are. We narrate our lives, shading every last detail, and even changing the script retrospectively, depending on the event, most of the time subconsciously. The storyteller never stops, except perhaps during deep sleep.

But another implication has to do with responsibility. If our sense of control is built on an unreliable account from automatic brain processes, how much control do we really have? Are there thresholds of responsibility, for instance, that can be determined by studying neural circuits? Dr. Gazzaniga and his wife, Charlotte, raised six children, so like any parents they had to determine levels of responsibility on the fly, just to get someone to set the table.

Yet questions like these became increasingly difficult to ignore for Dr. Gazzaniga, as he took on a more prominent role advising policy makers on the applications of brain science. He was appointed to a Congressional technology panel in 1991; in 2002, he took a position on the President's Council on Bioethics. And in 2007, he became the founding director of the John D. and Catherine T. MacArthur Foundation's [Research Network on Law and Neuroscience](#), which tracks and evaluates applications in the legal system.

There, in particular, brain science has had a growing impact. In recent years lawyers have begun to present brain images as evidence, usually to mitigate responsibility for a crime or to test veracity of testimony, as in a polygraph; increasingly, those images have been admitted. And more are coming: In imaging studies, for instance, neuroscientists have identified cortical areas that are highly active when people suppress impulses or other behaviors.

But there are clear shortcomings in the application of each of these methods in courtrooms. Brain images are snapshots, for one thing; they capture a brain state at only one moment in time and say nothing about its function before or after. For another, the images vary widely among people with healthy brains — that is, a "high" level of activity in one person may be normal in another. Can brain science tell exactly where automatic processes end and self-directed "responsible" ones end?

Not now and not likely ever, Dr. Gazzaniga argues in his book. Social constructs like good judgment and free will are even further removed, and trying to define them in terms of biological processes is, in the end, a fool's game.

"My contention is that, ultimately, responsibility is a contract between two people rather

than a property of the brain, and determinism has no meaning in this context," he writes in "Who's in Charge?"

Like generosity and pettiness, like love and suspiciousness, responsibility is what he calls a "strongly emergent" property — a property that, though derived from biological mechanisms, is fundamentally distinct and obeys different laws, as do ice and water.

Dr. Gazzaniga is not the first scientist making this case. It is far from a settled matter, in part because researchers do not yet have a complete picture of how automatic and deliberate systems interact biologically.

"I see Gazzaniga's point, and it would indeed be easiest if we could ignore conclusions derived from brain science and psychology when it comes to legal issues," said Ap Dijksterhuis, a psychologist at Radboud University Nijmegen, in the Netherlands, in an e-mail. "However, I do not think we can do this forever, and at some point, some key legal concepts such as accountability or responsibility will have to be redefined."

Until then, Dr. Gazzaniga's advice is to look for them where they've always been: in the hearts and moral intuitions of human beings, in their laws and customs.

And, it should be said, in their stories.

A version of this article appeared in print on November 1, 2011, on page D1 of the New York edition with the headline: Decoding the Brain's Cacophony.

Connect with The New York Times on Facebook.

- COMMENTS (59)
- E-MAIL
- PRINT
- REPRINTS

SPONSORED HEADLINES

[What's This?](#)

Get Free E-mail Alerts on These Topics

Healthcommunities.com

Thirdhand smoke: the smoke that sticks around.

The Atlantic

NASA's Unbelievable Footage of a Comet Hitting the Sun

HealthCentral.com

Can a Mediterranean diet help prevent Alzheimer's disease

More.com

Book Review: Sybil Exposed by Debbie Nathan

[Gazzaniga, Michael S](#)

[Psychology and Psychologists](#)

[Brain](#)

[University of California, Santa Barbara](#)

Search to learn more about this topic.



INSIDE NYTIMES.COM



HEALTH »



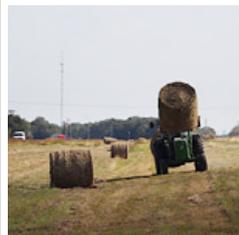
A Thanksgiving Feast, No Turkeys Allowed

OPINION »



Room for Debate: China's Health Care Crisis?

U.S. »



Hay Shortage in Drought-Stricken Texas

T MAGAZINE »



Lumière | Closin' Up the Ritz

OPINION »

The Stone: An Interview With A.C. Grayling

The philosopher discusses the challenges of creating meaning in our lives.

ARTS »



Similarity to Real People Is Completely Intended

[Home](#) | [World](#) | [U.S.](#) | [N.Y. / Region](#) | [Business](#) | [Technology](#) | [Science](#) | [Health](#) | [Sports](#) | [Opinion](#) | [Arts](#) | [Style](#) | [Travel](#) | [Jobs](#) | [Real Estate](#) | [Autos](#) | [Site Map](#)
© 2011 The New York Times Company | [Privacy](#) | [Your Ad Choices](#) | [Terms of Service](#) | [Terms of Sale](#) | [Corrections](#) | [RSS](#) | [Help](#) | [Contact Us](#) | [Work for Us](#) | [Advertise](#)