THE SOUNDS OF RESEARCH

UC Irvine scientists probe hearing and speech from a variety of angles.

SHERRI CRUZ
REGISTER WRITER

Why can humans still perceive sounds in a noisy environment? Why are some people good at reproducing accents? Why can we still understand what someone is saying, even if he or she has a pencil clenched between their teeth?

These are just some of the questions that researchers at the UCI Center for Hearing Research are trying to answer as they strive to understand how humans use hearing to produce speech.

UCI is one of the largest hearing-research centers in the world and is renowned for its inventions and multidisciplinary team of scientists – 39 researchers from five UCI schools and 10 departments – who explore hearing and speech from a variety of angles.

"There aren't very many centers where hearing, the brain and learning are all dealt with under the same roof," said Nina Kraus, professor and director of the Auditory Neuroscience Laboratory at Northwestern University in Illinois. "There are a very exciting group of scientists there."

The center's scientists want to better understand the many things that happen in between hearing sounds (low level) and producing speech (high level).

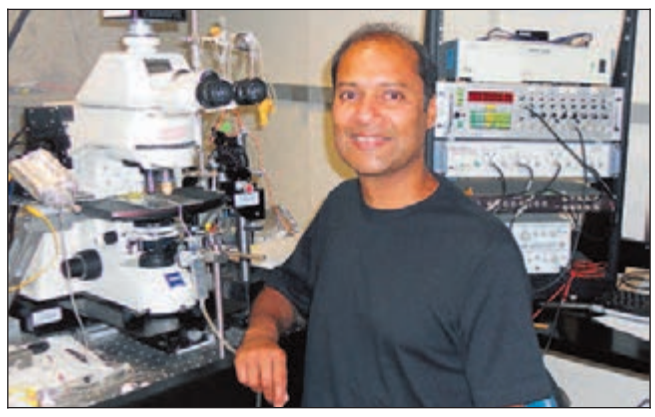
Meet some of the researchers in the hearing center and learn about their work.

CHAS METIVIER, FOR THE REGISTER

Fan-Gang Zeng, Arnold Starr and Hamid Djalilian, from left, meet recently at the UCI Center for Hearing Research. The facility is one of the largest in the nation.

Vocabulary

Otolaryngology: Diagnosis and treatment of the ear, nose and throat.
Neurotology: A subspecialty of otolaryngology: the diagnosis and treatment of neurological ear disorders.
Auditory cortex: The part of the brain that processes sound.
Cognition: Understanding the world through auditory and visual processing, logic and reasoning and memory.
Audiologist: Someone who measures hearing loss and fits people for hearing aids.
Cognitive neuroscience: The study of cognition using neuroscience.



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Raju Metherate studies nicotine's effects on the brain.

RAJU METHERATE
Professor of neurobiology and behavior at UC Irvine School or Biological Sciences and founding director of Center for Hearing Research

Metherate's lab studies the effects of nicotine on the auditory-processing part of the brain, which is the area that allows us to identify speech amid background noise and interpret language.

The auditory cortex is affected by nicotine because the brain has nicotine receptors, which normally respond to a neurotransmitter that allows us to pay attention to sounds. Nicotine can mimic that neurotransmitter.

Metherate has been looking at nicotine's effects on the brain for 15 years. For most of that time, he's been exploring how exposure to nicotine affects brain development of a fetus. "We've seen exclusively negative effects," he said.

Auditory deficits include problems distinguishing words and filtering out extraneous sounds as well as troubles understanding language spoken at a normal pace. Infants might not be able to orient to a new sound because they can't tell where the sound is coming from.

These days, Metherate has been studying the effects of nicotine on adults. Nicotine has the opposite effect on adults – it enhances auditory processing. "We want to understand how," he said.

Auditory problems are now treated with behavior therapy, but Metherate's research suggests there might be a nicotine drug therapy solution to problems processing sounds.

The nicotine would have to be given to the patient in a nonaddictive way – a way that bypasses the addiction part of the brain. Nicotine via smoking a cigarette or intravenous administration is addicting. But if it is given topically or orally, it is not addicting, he said, though it's not fully known why.

DR. HAMID DJALILIAN
Director of neurotology and skull base surgery and associate professor of otolaryngology and biomedical engineering

Djalilian sees patients who have hearing problems three to four times a week, which informs his research. And his research also informs his patient care.

"Usually when I'm seeing patients, I'm also thinking about what I can do to fix this problem," he said. "I look at problems I feel that have not been solved, or have not been solved well, and try to come up with ways to fix them."

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Alyssa Brewer maps the shared auditory and visual areas of the brain.

Much of Djalilian's work involves developing devices and software to resolve ear-related problems such as hearing loss and tinnitus. He spots trends by analyzing large databases of patients in California and across the country.

Djalilian and his colleagues came up with a device that could replace traditional behind-the-ear and noncochlear implantable hearing aids. The "direct drive hearing aid" is placed against the eardrum and directly vibrates the eardrum. It creates the same sound quality as an implantable hearing aid, but doesn't require surgery for implantation.

He has also come up with customized sound therapy for tinnitus (chronic ringing in the ear), and he's developing a console-game-like system to improve balance in older patients.

Imbalance leads to a sedentary lifestyle, which leads to loss of muscle mass and a higher chance of falling and suffering a hip fracture. "If someone gets a hip fracture, they accelerate towards death the year after. That's something we really need to do something to prevent," he said.

CHAS METIVIER, FOR THE REGISTER

Hamid Djalilian and colleagues created a nonimplantable device to replace traditional hearing aids.

"We used to think that it was an inner ear balance problem," he said. While there may be problems with an aging ear, the balance problem stems from the lack of activity, he said. The balance system is a "use it or lose it" system.

The goal is to turn research into products that can help people. "It's great to do research, but if people can't benefit from it, then there's no point," he said.

ALYSSA BREWER
Assistant professor of cognitive science

Her expertise is in mapping the visual region of the brain. She's interested in the common attributes of the auditory and visual areas of the brain. With a National Science Foundation grant, Brewer and her colleagues are in the process of mapping out those shared areas. When imaged, the areas appear to have a cloverleaf pattern.

The mapping will help researchers understand how language happens and how language disorders might occur.

"Even if we could see and map all of the neurons in the brain, we still need to know what those neurons are doing," she said. "I think of the brain as lots of repeating networks and circuits that are active at the same time and doing slightly different things."

GREGORY HICKOK
Professor of cognitive science and director of the Center for Cognitive Neuroscience

Hickok uses imaging and other methods to understand how humans produce speech. "It's a really remarkable ability, as you know if you've ever tried to talk to an automatic speech-recognition system."

Hickok's lab identified an area in the brain that links the auditory representations of speech – what speech sounds like – and motor representations of speech – the motor programs for controlling the tongue, lips and larynx. They named the area Sylvian-parietal-temporal, or Spt for short. "We've been able to identify it and map some of its properties."

A person who has damage to the area responsible for language may have trouble coming up with the right word. The condition is often caused by a stroke, which causes tissue loss – the loss of a physical connection between the auditory component and the motor component, he said.

GINNY RICHARDS
Professor of cognitive science and associate director for the Center for Hearing Research

"This is where the subjects go," Richards said, opening the door to the sound isolation booth in the Hearing Lab. The lab tests hearing in volunteers.

The lab also uses mathematical modeling to help audiologists fine-tune hearing devices.

Richards was a professor of psychology at the University of Pennsylvania before she came to UCI.

At first glance, psychology and hearing don't seem connected, but they are.

When people think of psychology, they think of clinical psychology, but learning, memory and perception are also part of psychology, she said. It's also an arm of cognitive neuroscience. "The general area called cognitive neuroscience has ... blossomed in the last 15 years."

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A Nobel for cochlear implant pioneers?

Up to 3 scientists could win for improvements to the device, UCI researcher says.

By **SHERRI CRUZ**
ORANGE COUNTY REGISTER

The Nobel Prize in Physiology or Medicine 2013 will be announced Oct. 7, and there's been a push within the global hearing research community to award the prize to inventors of the cochlear implant.

"Nobody can predict, but this year, there's a very good chance that as few as one or as many as three of the pioneers in cochlear implants will get a Nobel Prize," said Fan-Gang Zeng, director of the Center for Hearing Research at UC Irvine.

The inner-ear implant acts as a prosthetic cochlea, the organ that turns sound into impulses for the brain and allows deaf people to hear. "It is one of the technology wonders of our century," Zeng said.

Zeng, a renowned expert in the field of hearing research, began his research career in the 1990s at the House Research Institute, a nonprofit established by Dr. Howard House, whose brother, Dr. William House, invented the first cochlear implants.

Zeng has made his own contributions, inventing and commercializing an enhanced and less expensive cochlear implant and a device for relieving tinnitus, or chronic ear ringing.

Two people who should have won the prize, according to Zeng: William House, who invented the first cochlear implant in 1961, and Blair Simmons, who worked with House and made significant contributions to the implant. But both men have died, which makes them ineligible for the prize.

One of the top-tier candidates who could win the award is Graeme Clark, Zeng said. Clark, a professor at the University of Melbourne in Australia, improved the cochlear implant, inventing the first multi-channel cochlear implant, which was dubbed the "bionic ear." Multichannel implants organize sounds by frequencies.

Clark and two of his colleagues, Ingeborg Hochmair and Blake Wilson, recently won a $250,000 "American Nobels" award from the Albert & Mary Lasker Foundation for development of their cochlear implant.

Center for Hearing Research

The Center for Hearing Research at UC Irvine is a multidisciplinary group of UCI scientists bound by a common interest in hearing research.

Members: 39 researchers from five UCI schools (Medicine, Biological Sciences, Social Sciences, Engineering and Physical Sciences)

Research budget: $12 million

Funded by: private donors, grants, National Institutes of Health, UCI

Director: Fan-Gang Zeng, Ph.D., professor of otolaryngology, anatomy and neurobiology, biomedical engineering and cognitive sciences.

Origins: A group of researchers on campus had been meeting informally as a journal club since 1998. The "Things Auditory" group discussed papers published in scientific journals. The hearing center became a campus center in 2005.

A few of the center's inventions: Nonsurgical hearing aid; improved and less expensive cochlear implant; Serenade tinnitus relief; customized sound therapy for people with tinnitus

Website: chr.ss.uci.edu