



Restoring Communication Technologies to Support Speech

Losing the ability to speak can make it difficult to express yourself. Many things can damage the parts of the brain and body that work together to produce speech. Researchers are testing new tools to bypass the damage and restore communication.

Speech is a complicated process. Your brain must turn thoughts into words by firing electrical signals along nerve pathways to the muscles of the vocal tract. Those signals tell your lips, jaw, tongue, voice box, and lungs how to move together to produce sound.

“Talking uses almost 100 muscles,” says Dr. Sergey Stavisky, a neural engineer at the University of California, Davis. “If the pathways from the brain to those muscles are weak or fully blocked, a person can’t speak.”

Several tools can help people who have lost the ability to speak. A new type of system called a brain-computer interface, or BCI, reads signals from the brain and sends them to a computer. The computer then turns those signals into text, a spoken voice, or even movement on a screen. These technologies are helping some people communicate in new ways.

Addressing Speech Loss • There are many conditions that can impact your ability to speak. Amyotrophic



lateral sclerosis (ALS) is a progressive disease that weakens muscles and eventually leads to paralysis. Parkinson’s disease is a brain disorder that causes slowed movements, tremors, and stiff muscles.

Other conditions like brain tumors, seizures, strokes, and traumatic brain injuries can affect the parts of the brain we use for speech. Damage to different parts of the brain can lead to different speech issues. Aphasia is a condition in which a person has trouble using or understanding words. Apraxia is when you have difficulty moving your mouth and tongue to say words even when you know what you want to say.

“Speech-language therapists play a key role for people with conditions like aphasia or apraxia, which make it hard to recall words or plan the sounds of speech,” says Dr. Matthew Leonard, a neuroscientist at the University of California, San Francisco. “Through

practice and games, therapists help people rebuild word skills and find new ways to share their message.”

There are several tools available to help people who can’t speak. Letter boards are one of the oldest tools. A helper points to letters one by one on a printed board, and the person nods at the right one to spell words. It works without any power or screens, but it is slow and needs a partner

who knows the system.

Eye trackers use a small camera that follows the person’s eyes as they look at letters or pictures on a screen. When they hold their gaze on a choice, the computer picks it up. Eye trackers let people type on their own, but they can be tiring to use for long talks.

A head switch is a button that a person taps with their head to pick letters on a screen. A sip-and-puff device lets a person control a computer by breathing in or out through a straw-like tube.

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Both give people with limited movement a way to spell words.

But the traditional options may not be helpful for people with certain physical limitations. That's where BCIs can offer an alternative way to communicate.

Bypassing the Body • BCIs let people control computers, robots, or other devices using brain signals.

"We would not have been able to create our first successful BCI without the decade's worth of deep investigation into how the brain works," says Dr. Eddie Chang, a neurosurgeon at the University of California, San Francisco. Research from Chang's lab led to the first implantable BCI that was able to decode speech.

Some BCIs sit on the brain's surface. Others use tiny electrodes that go just under the surface. Both can detect when the brain tries to speak, even when the mouth cannot move. Currently, both of these BCIs require brain surgery and must be connected to a computer through a

small port in the skull. Researchers are also studying BCIs that can be implanted via a blood vessel of the brain and used wirelessly.

Other brain-signal technologies do not require an implant. Devices called EEG headsets can be worn as headbands or caps. They can pick up brain signals and decode simple speech patterns, but they cannot translate smooth, ongoing language.

"The technology used to create BCIs has advanced quickly over the last five years," says Chang.

Stavisky's team has already developed a BCI that connects to a home computer to restore speech for people with vocal tract paralysis.

But advances in technology are only part of the challenge. To turn brain activity into speech, researchers need to understand which parts of the brain are involved and to determine where to place the BCIs.

Leonard's team researches how each person's brain turns speech sounds into words to help guide BCI development and placement.

"We used to think that we could just use anatomy to find where speech and language is processed in the brain, but it turns out that there is a lot of variation from person to person," says Dr. Jaimie Henderson, a neurosurgeon at Stanford University. For a BCI to work well, it needs to detect strong signals from specific areas of the brain.

A recent focus for Henderson's team has been using functional MRIs to study where to place BCI sensors for the clearest brain signal recordings. A functional MRI allows doctors to watch a person's brain while it's at work. The images can show where the brain processes speech and language. This helps doctors determine where to place the BCI sensors.

What's Next? • While EEG devices are currently available commercially, right now, implanted speech BCIs are available only through clinical trials. People who might be eligible to participate include those with ALS, lasting stroke symptoms, a spinal cord injury, or paralysis. To search for a clinical trial, visit clinicaltrials.gov.

"Our team and others have shown that people can use BCI devices on a day-to-day basis to restore communication," Henderson says. He and other researchers hope that after a few more years of testing, these devices will be more accessible to those who need them.

If you have a loved one who has lost their ability to speak, there are ways you can help improve communication. See the Wise Choices box for tips. ■

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Wise Choices

Helping Someone With Speech Loss

- Give the person more time than you normally would to communicate.
- Use body language and gestures as visual cues when possible.
- Ask "yes" or "no" questions or give clear choices for possible answers.
- Let them know when you don't understand, and repeat back what you did understand from their message.
- Ask their doctors about tools that can help.



Web Links

For more about speech technologies, see "Find More Information" in the online article: newsinhealth.nih.gov/2026/10/restoring-communication

Professor Thymus

Training the Body to Fight Disease

Just as children learn in school, some of the cells that protect us from disease also need an education. Cells called T cells attend class in the thymus. The thymus teaches the T cells what to attack and what to leave alone to keep us healthy. Researchers are studying how the thymus trains these cells, with the goal of finding new ways to boost disease-fighting abilities.

T cells are one of the most important parts of our body's disease defense system, called the immune system. The immune system is made up of many different cells that defend us from threats like bacteria and viruses.

The thymus is the reason for the "T" in T cell. After they are born,

immature T cells travel to the thymus. Once there, they mature and specialize. They also learn how to recognize friend from foe. Afterward, the thymus tells the mature T cells where in the body to go.

"Those cells come into the thymus as kind of a blank slate, much like children come to school," explains Dr. Kristin Hogquist, an expert on the immune system at the University of Minnesota. "And then the thymus is where they get all of the sophisticated instructions about how to function."

Some babies are born without a thymus. Not having a thymus leaves these babies at risk for life-threatening infections. They also often develop illnesses called autoimmune diseases. Those illnesses occur when your immune system attacks your body.

Babies born without a thymus can't survive more than a few years without treatment. Fortunately, doctors can take a piece of the thymus from a donor and put it into a baby's body.

"That piece of thymus will attract immature T cells, and it will build a school where those T cells can be educated," Hogquist says.

For a long time, scientists thought that adults didn't need a thymus. That's because the thymus naturally shrinks and becomes less active as we age. But new research is showing that the thymus remains important in adulthood.

Some of that research involves studying adults who had part or all of their thymus removed. The thymus is in the upper part of the chest, so "surgeons will sometimes remove part of the thymus to gain access to the heart," Hogquist says.



A recent NIH-funded study looked at adults who have had their thymus removed. The study found that removing a person's thymus made it more likely they would die from cancer or an autoimmune disease. Another study found that adults with a more active thymus might be less likely to die from any cause.

Learning more about the thymus could lead to ways to make it more active in adults. Hogquist is trying to figure out what molecules the thymus uses to teach our T cells.

"You can try to restore a whole functioning thymus to fix one of the problems in it, or you can provide one molecule," explains Hogquist. "But we've got to know what those molecules are."

See the Wise Choices box to learn more about what can harm the thymus and make it harder for your body to fight infections. ■



Wise Choices

Thymus Under Attack

Certain illnesses and medical treatments can damage the thymus:

- **Bone marrow transplants** that lead to graft-versus-host disease. Bone marrow is the spongy material in bones that produces immune cells. Graft-versus-host disease occurs when a person's new bone marrow makes immune cells that attack the thymus and other organs.
- **Steroid medications** to treat autoimmune illnesses. These can cause the thymus to shrink and become less active.
- **Chemotherapy and radiation therapy.** These cancer treatments can damage the thymus. In rare cases, the thymus can be the starting point for cancer.
- **Severe infections.** When bacteria or viruses run rampant in the body, they can temporarily make the thymus less active.



Web Links

For more about the thymus, see "Find More Information" in the online article: newsinhealth.nih.gov/2026/10/professor-thymus



Health Capsules

For more information, please visit our website to see these stories online.

Coating Helps Reduce Cavities in Kids

A recent study showed that applying a protective coating on kids' teeth can help stop tooth decay from growing and causing problems.

More than 40% of U.S. children have tooth decay. Tooth decay is caused by sugar-fueled bacteria that make acid that damages the tooth surface. The bacteria live in a sticky, colorless film called plaque. Over time, decay can lead to holes in the teeth, called cavities. If not treated, decay can lead to pain, infections that can spread, and even tooth loss.

A research team studied 830 children between ages 1 and 6 with at least one cavity. At the start of the study, one of two coatings was applied to the children's teeth.

About half of the kids were treated with a coating containing silver diamine fluoride. It kills the bacteria that cause cavities and also makes teeth harder. The other half were given a similar coating but without any active ingredients. The coatings were reapplied six months later.

The kids were given check-ups at

the start of the study. They also had follow-up exams three, six, and eight months later. The coating with silver diamine fluoride helped stop tooth decay in more than half the cavities. The other coating stopped about 17% of cavities.

"This is a very effective and safe treatment—even in children as young as 1," says Dr. Margherita Fontana at the University of Michigan School of Dentistry, who led the study. ■

Spotting Mental Health Risks in Kids

Doctors know that children who experience trauma have a higher risk of physical and mental health issues. Traumas can include abuse, neglect, or domestic violence.

Some children face a different challenge: unpredictable home environments. They may not have a consistent bedtime routine. Their parents may have mood swings or the relationship between their parents may be unhealthy.

Unpredictable parenting and a lack of home routines have been linked to poorer mental health in kids. But

traditional health screenings don't always ask about these concerns.

A team of researchers designed screening questions about how unpredictable life is at home. They tested whether adding these questions to standard screening tests helped identify kids at risk for mental health issues.

The study looked at 30,000 children across 19 primary care clinics in California. The team compared mental health diagnoses from electronic health records with the screening test results.

The new questions helped find kids at risk for depression and sleep disorders. Adding this information to the screenings gave a clearer picture of mental health risks.

"For parents, this isn't about creating a perfect home," explains Dr. Tallie Z. Baram at the University of California, Irvine. "It's about recognizing that consistency matters. Small routines and predictable patterns in daily life can support healthy development."

More studies are needed to learn how best to help at-risk kids. ■



Featured Website

Your Healthiest Self: Wellness Toolkits

www.nih.gov/wellnesstoolkits

We each have a unique "healthiest self." We have different minds, bodies, living situations, and people helping to shape our health and well-being. These toolkits of-

fer science-based health tips in five different areas. Find ways to improve your relationships, emotional and physical well-being, disease defenses, and surroundings.

Your Healthiest Self: Wellness Toolkits

Each person's "healthiest self" is different. We have different bodies, minds, living situations, and people influencing our lives. Each area can impact your overall health. This means we each have a unique set of health needs. Use our wellness toolkits to find ways to improve your well-being in any area you'd like.

En español



Your Surroundings
Learn how to make your environment safer and limit your exposure to potentially harmful



Your Feelings
Find out how to successfully handle life's stresses and adapt to change and difficult times.



Your Body
Discover which physical health habits can help decrease your stress, lower your risk of disease.

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