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**Touching moments in prosthetics: New bionic limbs that can "feel"**

By Washington Post, adapted by Newsela staff

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Phantom pain was all that Keven Walgamott had left of the limb he lost over a decade ago — until he first tried on the LUKE Arm. Walgamott could "feel" his arm again thanks to the bionic arm that a team at the University of Utah developed.

Although traditional prosthetic limbs are useful for many people who have lost limbs, they have limitations because people do not feel as though prosthetics are parts of their own body. Researchers around the world have been developing prosthetics that more closely mimic the human body. These new prosthetics are bionic body parts that can touch, feel and even learn new things.

"Touch isn't a single sense," said Gregory Clark, associate professor of biomedical engineering at the University of Utah and lead researcher of the study. "When you first touch objects with a natural hand, there's an extra burst of neural impulses."

**"Translating" Neural Impulses into Characteristics**

The brain then "translates" neural impulses into characteristics such as firmness, texture and temperature. All of this information is crucial in deciding how we should interact with the object. When we hold a basketball, we interact with it differently than we do a beach ball. By using the LUKE Arm (named after the "Star Wars" hero Luke Skywalker), Walgamott could "feel" the fragility of a mechanical egg as he held it, just as he would have experienced with a natural limb.

As he performed everyday activities with the prosthetic — such as holding his wife's hand, sending a text message and plucking grapes from a bunch — Walgamott told researchers that it felt like he had his arm back. Even his phantom pain was reduced. Clark explained that was because the brain was tricked into believing that Walgamott's prosthetic hand was his real hand.

Clark's team were able to achieve these results by stimulating the sensory nerve fibers in a "biologically realistic" manner. They used a computer algorithm to replicate the impulses the brain normally receives from a native arm.

**Brain Interprets Electrical Signals as Real**

Clark said that LUKE Arm users "can feel the location and the contraction force of their muscles even when muscles aren't there. That's because we can send electrical signals from the muscles, so the brain interprets them as real."

**Explain what the BCI or brain computer interface does:**

The brain-computer interface (BCI) is a critical component for bionic prosthetics that enables communication between the brain and the prosthetic. The LUKE Arm uses a neural interface that users can easily apply to themselves. Yet in other mind-controlled prosthetics, brain implants are used to send instructions to a robotic limb. However, this means that users must undergo precision brain surgery, which can be risky, expensive, and requires recovery time. Thanks to new technology, this might be about to change.

Bin He, professor and head of biomedical engineering at Carnegie Mellon University, and his colleagues have been working on a noninvasive, high-precision BCI. In June his team reported that they have developed a "mind-controlled robotic arm." According to He, the arm "demonstrates the capability for humans to continuously control a robotic device using noninvasive EEG signals."

The term "noninvasive" is key. In the past, noninvasive BCIs have shown promising results, but only in performing distinct actions such as pushing a button. Yet when it comes to a continuous action such as tracking a cursor on a computer screen, noninvasive BCIs have resulted in jerky, disjointed movements. In He and his team's demonstration, the subject mentally controlled a robotic arm in tracking a cursor move on a computer screen. The prosthetic finger was able to follow the cursor in a smooth, continuous path just as a real finger would. While researchers used a computer-wired EEG cap on the subject during the demonstration, He said that it is not necessary for the BCI to function.

**Thought-Controlled Robotic Devices**

He said that a smartphone app programmed with EEG recordings and wireless electrodes could enable everyday use. This could pave the way for people to use thought-controlled robotic devices without undergoing brain surgery.

Our native limbs are trained to perform actions ranging from walking to the highly precise movements required to perform neurosurgery. Prosthetic limbs also have to be calibrated for specific uses. Engineers at Joseph Francis's lab at the University of Houston have been working on a BCI that can update itself with user feedback. This system will enable the prosthetic to learn how to perform new actions in accordance with the user's needs.

In 2018, the Imperial College London and the University of Göttingen collaborated to develop a bionic hand. The hand used a human-machine interface that interpreted the wearer's intentions and sent commands to the artificial limb. Using machine learning techniques, the hand can "learn" how to perform new skills much like a real hand.

"Our main goal is to let patients control the prosthetic as though they were their biological limbs," said lead researcher Dario Farina.

Researchers said bionic body parts can work for both amputees and paralyzed people. Although paralyzed users may have a higher likelihood of experiencing nerve or spinal cord damage, He said that "a noninvasive BCI should apply to both. The BCI system can be tailored to particular needs."

**Bionic Add-Ons with Superhuman Abilities**

And the next frontier? If BCIs and other neural interfaces provide a means to connect our brains with external devices that extend our bodies' capabilities, would it be possible to develop bionic add-ons that bestow superhuman abilities?

**What are some “bionic add-on” that currently give us “superhuman abilities”?**

"In a sense, yes," Clark said. "Indeed, we already do. Glasses restore normal vision to the nearsighted. But telescopes and microscopes allow us to see what would be otherwise unseeable. Canes assist in walking after injury, but fiberglass vaulting poles allow us to clear superhuman heights. Exoskeletons provide important assistive technologies after spinal cord injury or stroke. Yet they can be used to increase the power and endurance of intact individuals."

**But in other ways, bionic parts are no match for nature.**

"The LUKE Arm contains only 19 sensors, and generates six different types of movements. Similarly, the neural interface we use can capture or convey hundreds of different electrical signals from or to the brain," Clark said. "That's a lot, but both are impoverished compared with the thousands of motor and sensory channels of the human body."

The field of biomedical engineering, Clark added, exists to improve nature when it goes awry through illness or accident. "But we also try to understand and use nature to improve engineering and ourselves," he said.

**Please respond:**

* **Using evidence from this text, explain how the most advanced prosthetic limbs might learn to communicate with the wearer's brain?**
* **Using evidence from this text, explain what a major benefit of the new prosthetic technology might be.**
* **Write a short summary of the article.**
* **What did the author want you to learn from this article?**