Press Release

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Controlling prosthetic hands more precisely by the power of thought

Neuroscientists show how fine motor skills of neural prostheses can be improved

Göttingen, October 16, 2024. **Researchers at the German Primate Center – Leibniz Institute for Primate Research in Göttingen have developed a novel training protocol for brain-computer interfaces in a study with rhesus monkeys. The method enables precise control of prosthetic hands using signals from the brain alone. For the first time, researchers were able to show that the neural signals that control the different hand postures in the brain are primarily important for this control, and not, as previously assumed, signals that control the movement's velocity. The results are essential for improving the fine control of neural hand prostheses, which could give paralyzed patients back some or all of their mobility (Neuron).**

Carrying shopping bags, pulling a thread into the eye of a needle – power and precision grips are part of our everyday lives. We only realize how important (and great) our hands are when we can no longer use them, for example due to paraplegia or diseases such as ALS, which cause progressive muscle paralysis.

In order to help patients, scientists have been researching neuroprostheses for decades. These artificial hands, arms or legs could give people with disabilities their mobility back. Damaged nerve connections are bridged via brain-computer interfaces that decode the signals from the brain, translate them into movements and can thus control the prosthesis. Until now, however, hand prostheses in particular have lacked the necessary fine motor skills to be used in everyday life.

"How well a prosthesis works depends primarily on the neural data read by the computer interface that controls it," says Andres Agudelo-Toro, scientist in the Neurobiology Laboratory at the German Primate Center and first author of the study. "Previous studies on arm and hand movements have focused on the signals that control the velocity of a grasping movement. We wanted to find out whether neural signals representing hand postures might be better suited to control neuroprostheses."

For the study, the researchers worked with rhesus monkeys *(Macaca mulatta)*. Like humans, they have a highly developed nervous and visual system as well as pronounced fine motor skills. This makes them particularly suitable for researching grasping movements.

To prepare for the main experiment, the scientists trained two rhesus monkeys to move a virtual avatar hand on a screen. During this training phase, the monkeys performed the hand movements with their own hand while simultaneously seeing the corresponding movement of the virtual hand on the screen. A data glove with magnetic sensors, which the monkeys wore during the task, recorded the animals' hand movements.

Once the monkeys had learned the task, they were trained to control the virtual hand in a next step by "imagining" the grip. The activity of populations of neurons in the cortical brain areas that are specifically responsible for controlling hand movements was measured. The researchers focused on the signals that represent the different hand and finger postures, and adapted the algorithm of the brain-computer interface, which translates the neural data into movement, in a corresponding protocol.

"Deviating from the classic protocol, we adapted the algorithm so that not only the destination of a movement is important, but also how you get there, i.e., the path of execution," explains Andres Agudelo-Toro. "This ultimately led to the most accurate results."

The researchers then compared the movements of the avatar hand with the data of the real hand that they had previously recorded and were able to show that these were executed with comparable precision.

"In our study, we were able to show that the signals that control the posture of a hand are particularly important for controlling a neuroprosthesis," says Hansjörg Scherberger, head of the Neurobiology Laboratory and senior author of the study. "These results can now be used to improve the functionality of future brain-computer interfaces and thus also to improve the fine motor skills of neural prostheses."

Original publication

Agudelo-Toro A, Michaels JA, Sheng W-A, Scherberger H (2024): Accurate neural control of a hand prothesis by posture-related activity in the primate grasping circuit. Neuron, https://doi.org/10.1016/j.neuron.2024.09.018

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Printable pictures can be found under the following link:
https://medien.dpz.eu/pinaccess/showpin.do?pinCode=WwoveJdFOt10.
The press release is also available on our website after the embargo has lifted. We kindly request a specimen copy in case of publication.

The German Primate Center (DPZ) – Leibniz Institute for Primate Research conducts biological and biomedical research on and with primates in the fields of infection research, neuroscience and primate biology. The DPZ maintains five field stations in the tropics and is the reference and service center for all aspects of primate research. The DPZ is one of 96 research and infrastructure facilities of the Leibniz Association.

Images and captions

Printable images: https://medien.dpz.eu/pinaccess/showpin.do?pinCode=WwoveJdFOt10
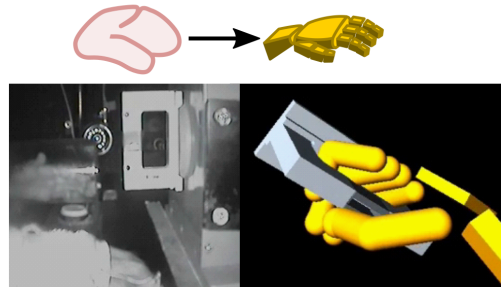

In a study with rhesus monkeys, neuroscientists at the German Primates Center have investigated how the functionality of brain-computer interfaces and thus also the fine motor skills of neuroprostheses can be improved. Photo: Andres Agudelo-Toro

Native Task
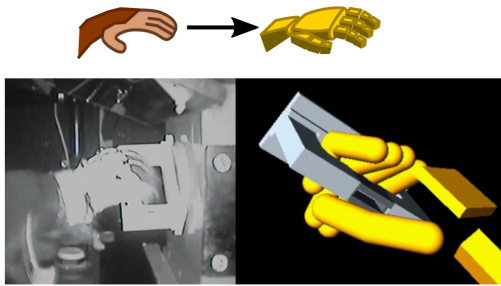
BCI Task

The experiment was performed in two phases. In the first phase the monkey leaned to control a hand "avatar" in a virtual reality environment using their own hands (native task above). The monkey's "real" hand can be seen on the handle on the left, the avatar hand on the right. In the second phase the monkeys were trained for several weeks to move the virtual hand with their own thoughts, without need to move their real hands (BCI task below). On the left you can see the monkey's hands not touching the handle, on the right the avatar hand executing the grasp. Image: Neuron, Agudelo-Toro *et al.* 2024
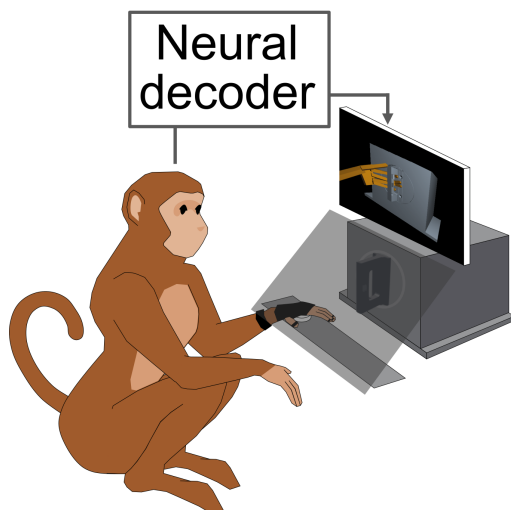
To convert the brain signals to movements of the prosthetic hand the researchers used a neural decoder. A neural decoder is a computer algorithm that deciphers the meaning of neuronal spikes into movement signals. Image: Neuron, Agudelo-Toro *et al.* 2024

Two rhesus monkeys in the animal facility at the German Primate Center. Photo: Anton Säckl

Dr. Andres Agudelo-Toro is a scientist in the Neurobiology Laboratory at the German Primate Center. Photo: Miriam Toro

Prof. Hansjörg Scherberger is head of the Neurobiology Laboratory at the German Primate Center. Photo: Karin Tilch