RESEARCH NEWS STORY

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The Sixth Finger: How Our Brain Takes to Additional Independent Body Parts

Researchers investigate whether the human brain can accept a new, independent artificial finger as a body part

Can the human brain think of an independent, artificial appendage as its own? While many studies have explored this question, the artificial limbs used in them have been operated by an existing limb. In a new study, researchers from Japan and France tested for how well a robotic "sixth finger" that can be operated independently of any other limbs was perceived as a body part, demonstrating that our brain can "own" even independent limbs.

How do we know that our body parts, such as our hands and feet, are really ours? This seems like a strange question to ask. We feel convinced that our body parts must obviously belong to us. However, the representation of what constitutes our "body" in our brain is remarkably flexible. As demonstrated in a famous experiment called the "rubber hand illusion," and in follow-up studies stretching over several decades, the brain can be easily tricked into accepting artificial limbs as parts of our body. Understanding this flexibility is very useful, for example, to partly explain how we adapt to changes that happen in our body as we grow up, and, in case of major accidents causing paralysis or loss of limbs, to what extent we can "own" a substitute prosthetic limb.

But, is there a limit to this flexibility? Can we own additional new limbs, such as an extra finger or arm, just as well? The question has been addressed in several studies, with researchers attaching artificial limbs ranging from extra fingers to even a tail. However, in all these studies, the movement of the added limb was controlled by an existing limb and any tactile feedback to the new limb was provided to the innate limb itself. This makes it no different from replacing the innate limb with a new one. *"It remains unclear if our brain can 'embody' a truly independent additional limb—one that can function independently of any other limbs, and one which gives us tactile feedback in the same independent manner,"* explains Dr. Gowrishankar Ganesh, Senior Researcher at the Centre National de la Recherche Scientifique (CNRS), France, who studies human-centric robotics.

To find out, Dr. Ganesh and the group of Dr. Yoichi Miyawaki from The University of Electro-Communications, Japan developed, in a new study, an artificial robotic "sixth finger" that can be worn on the hand as an appendage. This paper was made available online on 14 February 2022 and was published in Volume 12 of the journal *Scientific Reports* on 14 February 2022. Additionally, an introduction movie of the work is now available on YouTube.

To ensure that this robotic finger is not controlled by any existing limb, they used the part of the electrical activity of the forearm muscles that do not govern any limb movement, to

operate the sixth finger. Furthermore, they attached a haptic slider to the robotic finger to provide tactile feedback of the finger's movement to the side of the palm.

The researchers then studied 18 adult participants who were asked to adapt to the new finger. To do this, the participants had to move both their real and artificial fingers on cues provided by music and visuals while playing video games. The researchers then examined how the participants perceived their hands after the adaptation with questionnaires and behavioral tests that gauged their perception of the location of their little finger in space.

They found that all the participants could move their sixth finger with ease. Interestingly, the user's subjective rating of how much they perceived the sixth finger to be a part of their body was strongly associated with their uncertainty regarding the little finger's location in space. *"The more the sixth finger was embodied, the more the participant felt unsure where the extremity of his hand lay. This was an indication that they perceived the sixth finger as a part of their hand,"* comments Dr. Miyawaki.

The implication of this finding is remarkable. It shows that the brain can not only embody substitute artificial limbs but new limbs altogether. This could very well pave the way to artificial wearable limbs in the future. *"From the point of view of basic science, one may wonder how our brain changes when an independent new limb is embodied. Certain regions like the motor and sensory cortex are known to incorporate a spatial map of our limbs, and understanding the changes that occur in these maps can enable us to understand the extent and limit of embodiment,"* comments Dr. Miyawaki. *"It would be interesting to extend our study to verify whether humans can also embody limbs they do not possess, such as tails and wings!"*

An interesting prospect to contemplate, for sure!

Reference

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