

Third Thumb: People have no difficulty getting to grips with an extra thumb, study finds

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Image showing the Third Thumb design from the perspective of the wearer.
Credit: Dani Clode Design & The Plasticity Lab

Cambridge researchers have shown that members of the public have

little trouble in learning very quickly how to use a third thumb—a controllable, prosthetic extra thumb—to pick up and manipulate objects.

The team tested the [robotic device](#) on a diverse range of participants, which they say is essential for ensuring new technologies are inclusive and can work for everyone. The [results](#) are published in *Science Robotics*.

An emerging area of future technology is motor augmentation—using motorized [wearable devices](#) such as exoskeletons or extra robotic body parts to advance our motor capabilities beyond current biological limitations.

While such devices could improve the quality of life for healthy individuals who want to enhance their productivity, the same technologies can also provide people with disabilities new ways to interact with their environment.

Professor Tamar Makin from the Medical Research Council (MRC) Cognition and Brain Sciences Unit at the University of Cambridge said, "Technology is changing our very definition of what it means to be human, with machines increasingly becoming a part of our everyday lives, and even our minds and bodies.

"These technologies open up exciting new opportunities that can benefit society, but it's vital that we consider how they can help all people equally, especially marginalized communities who are often excluded from innovation research and development.

"To ensure everyone will have the opportunity to participate and benefit from these exciting advances, we need to explicitly integrate and measure inclusivity during the earliest possible stages of the research and development process."

Dani Clode, a collaborator within Professor Makin's lab, has developed the Third Thumb, an extra robotic thumb aimed at increasing the wearer's range of movement, enhancing their grasping capability and expanding the carrying capacity of the hand. This allows the user to perform tasks that might be otherwise challenging or impossible to complete with one hand or to perform complex multi-handed tasks without having to coordinate with other people.

The Third Thumb is worn on the opposite side of the palm to the biological [thumb](#) and controlled by a pressure sensor placed under each big toe or foot. Pressure from the right toe pulls the Thumb across the hand, while the pressure exerted with the left toe pulls the Thumb up toward the fingers. The extent of the Thumb's movement is proportional to the pressure applied, and releasing pressure moves it back to its original position.

In 2022, the team had the opportunity to test the Third Thumb at the annual Royal Society Summer Science Exhibition, where members of the public of all ages were able to use the device during different tasks.

Over the course of five days, the team tested 596 participants, ranging in age from three to 96 years old and from a wide range of demographic backgrounds. Of these, only four were unable to use the Third Thumb, either because it did not fit their hand securely, or because they were unable to control it with their feet (the pressure sensors developed specifically for the exhibition were not suitable for very lightweight children).

Participants were given up to a minute to familiarize themselves with the device, during which time the team explained how to perform one of two tasks.



The Third Thumb worn by different users. Credit: Dani Clode Design / The Plasticity Lab

The first task involved picking up pegs from a pegboard one at a time with just the Third Thumb and placing them in a basket. Participants were asked to move as many pegs as possible in 60 seconds. A total of 333 participants completed this task.

The second task involved using the Third Thumb together with the wearer's biological hand to manipulate and move five or six different foam objects. The objects were of various shapes that required different manipulations to be used, increasing the dexterity of the task. Again, participants were asked to move as many objects as they could into the basket within a maximum of 60 seconds. In all, 246 participants

completed this task.

Almost everyone was able to use the device straightaway. 98% of participants were able to successfully manipulate objects using the Third Thumb during the first minute of use, with only 13 participants unable to perform the task.

Ability levels between participants were varied, but there were no differences in performance between genders, nor did handedness change performance—despite the Thumb always being worn on the right hand. There was no definitive evidence that people who might be considered 'good with their hands'—for example, they were learning to play a musical instrument, or their jobs involved manual dexterity—were any better at the tasks.



The Third Thumb helping the user to open a bottle. Credit: Dani Clode Design / The Plasticity Lab

Older and younger adults had a similar level of ability when using the new technology, though further investigation just within the older adults age bracket revealed a decline in performance with increasing age. The researchers say this effect could be due to the general degradation in sensorimotor and cognitive abilities that are associated with aging and may also reflect a generational relationship to technology.

Performance was generally poorer among younger children. Six out of the 13 participants that could not complete the task were below the age of 10 years old, and of those that did complete the task, the youngest children tended to perform worse compared to older children. But even [older children](#) (aged 12-16 years) struggled more than young adults.

Dani said, "Augmentation is about designing a new relationship with technology—creating something that extends beyond being merely a tool to becoming an extension of the body itself. Given the diversity of bodies, it's crucial that the design stage of wearable technology is as inclusive as possible. It's equally important that these devices are accessible and functional for a wide range of users. Additionally, they should be easy for people to learn and use quickly."

Co-author Lucy Dowdall, also from the MRC Cognition and Brain Science Unit, added, "If motor augmentation—and even broader human-machine interactions—are to be successful, they'll need to integrate seamlessly with the user's motor and cognitive abilities. We'll need to factor in different ages, genders, weight, lifestyles, disabilities—as well as people's cultural, financial backgrounds, and even likes or dislikes of technology. Physical testing of large and diverse groups of individuals is

essential to achieve this goal."

There are countless examples where a lack of inclusive design considerations has led to technological failure:

- Automated speech recognition systems that convert spoken language to text have been shown to perform better listening to white voices over Black voices.
- Some augmented reality technologies have been found to be less effective for users with darker skin tones.
- Women face a higher health risk from car accidents, due to car seats and seatbelts being primarily designed to accommodate 'average' male-sized dummies during crash testing.
- Hazardous power and industrial tools designed for a right-hand dominant use or grip have resulted in more accidents when operated by left-handers forced to use their non-dominant hand.

More information: Dani Clode et al, Evaluating Initial Usability of a Hand Augmentation Device Across a Large and Diverse Sample, *Science Robotics* (2024). [DOI: 10.1126/scirobotics.adk5183](https://doi.org/10.1126/scirobotics.adk5183).
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