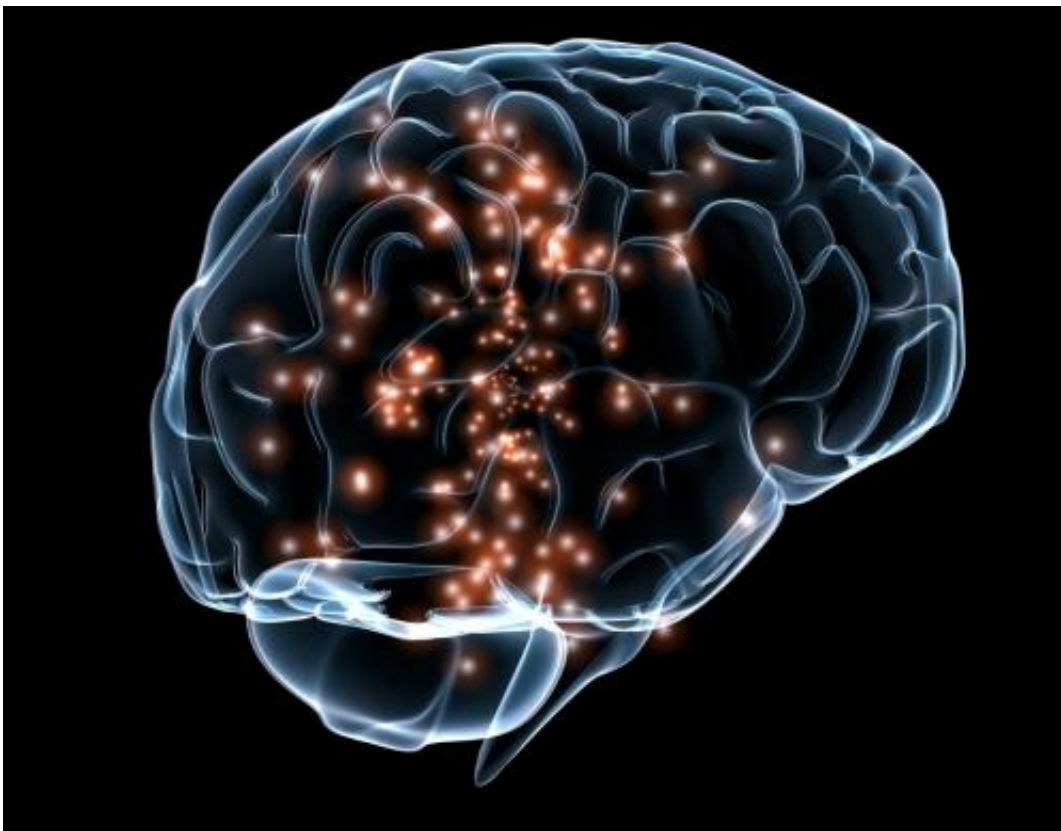


Getting a handle on brain organization: Study finds even those born without hands show hand-tool overlap

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Credit: Wikimedia Commons

Tool use has long been considered one of the behaviors that makes humans, well, human.

In fact, studies have found that the use of tools has become so deeply ingrained in human brains that, when shown pictures of hands or pictures of tools, there is an overlap in the regions of the [brain](#) showing activity.

But would the same be true, Ella Striem-Amit wondered, for someone who was born without hands? Would that overlap still exist, even if someone had never had the opportunity to handle tools, or would the brain organize itself in a different way?

The answer, she said, is no - but also yes.

In a study published this week in the *Proceedings of the National Academy of Sciences*, Ella Striem-Amit and Gilles Vannuscorps, post-doctoral researchers in Alfonso Caramazza's Cognitive Neuropsychology Laboratory, show the hand-tool overlap exists - even in people born without hands - suggesting the connection between the two hands and tools is deeply ingrained in [brain organization](#). But the study also found tantalizing clues that, because those born without hands perform many daily functions using their [feet](#), a similar overlap had developed in some of them between the foot- and tool-recognition areas of their brains.

"The general question we wanted to explore is whether brain organization is innately determined or if it depends on experience," Striem-Amit said. "What we found is that the majority of our subjects showed hand-tool overlap. That suggests these connectivity patterns may be hard-wired... (because they) can still be found in people who don't have experience manipulating tools."

To explore how brain organization might be different in people born without hands, Striem-Amit and colleagues turned to [functional magnetic resonance](#) imaging, or fMRI.

Working with co-author Gilles Vannuscorps, a post-doctoral researchers

Caramazza's lab, who had previously conducted studies involving participants born without hands, the team recruited a number of volunteers and tracked their brain activity as they were shown images of both hands and feet, as well as images of both tools and large, non-manipulatable objects like tables and refrigerators.

"There's an area in the visual cortex that shows selectivity both for viewing hands and for viewing tools," Striem-Amit explained. "So what we were looking at is conjoined selectivity. What we wanted to see was to what extent is that overlap determined by your own experience of manipulating tools with your own hands."

Of the five participants born without hands, she said, four showed hand-tool overlap, suggesting the hand-tool overlap in the brain may be innate.

But while the study points to some level of innate brain organization, the results also hinted that - under certain circumstances - experience may also play a role.

Lacking hands, all the handless study participants use their feet to perform everyday tasks from playing musical instruments to using a smartphone, and the MRI scans showed that two participants had an overlap - similar to the hand-tool overlap - between feet and tools. Surprisingly, one control subject also showed a similar foot-tool overlap, suggesting that there may not be a direct link between using your feet and an overlap with the tool region.

"We can't really draw robust conclusions from that," Striem-Amit said. "It hints that there is some plasticity in the system, and the fact that they use their feet all the time has an effect."

Going forward, Striem-Amit is working to understand how the motor cortex is organized and is contemplating future studies involving the

[hand-tool](#) overlap.

"One thing we'd like to do but haven't done is study the spouses and family members of people who were born without hands," she said. "They have seen them interact with tools with their feet, but haven't done it themselves. It's an interesting question."

Ultimately, Striem-Amit said, the study suggests that - for some foundational types of brain organization - experience is simply unnecessary.

"If they don't need sensory motor experience for this, then it may be that they don't need any type of experience for this," Striem-Amit said. "It may be that this neural mechanism develops regardless of any experience at all."

More information: Ella Striem-Amit et al., "Sensorimotor-independent development of hands and tools selectivity in the visual cortex," *PNAS* (2017). www.pnas.org/cgi/doi/10.1073/pnas.1620289114

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