Research determines how the brain computes tool use

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(Medical Xpress)—With a goal of helping patients with spinal cord injuries, Jason Gallivan and a team of researchers at Queen's University's Department of Psychology and Centre for Neuroscience Studies are probing deep into the human brain to learn how it manages basic daily tasks.

The team's most recent research, in collaboration with a group at Western University, investigated how the human brain supports tool use. The researchers were especially interested in determining the extent to which brain regions involved in planning actions with the hand alone would also be involved in planning actions with a tool. They found that although some brain regions were involved in planning actions with either the hand or tool alone, the vast majority were involved in planning both hand- and tool-related movements. In a subset of these latter brain areas the researchers further determined that the tool was in fact being represented as an extension of the hand.

"Tool use represents a defining characteristic of high-level cognition and behaviour across the animal kingdom but studying how the brain – and the human brain in particular – supports tool use remains a significant challenge for neuroscientists" says Dr. Gallivan. "This work is a considerable step forward in our understanding of how tool-related actions are planned in humans."

Over the course of one year, human participants had their brain activity scanned using functional magnetic resonance imaging (fMRI) as they

reached towards and grasped objects using either their hand or a set of plastic tongs. The tongs had been designed so they opened whenever participants closed their grip, requiring the participants to perform a different set of movements to use the tongs as opposed to when using their hand alone.

The team found that mere seconds before the action began, that the neural activity in some brain regions was predictive of the type of action to be performed upon the object, regardless of whether the hand or tool was to be used (and despite the different movements being required). By contrast, the predictive neural activity in other brain regions was shown to represent hand and tool actions separately. Specifically, some brain regions only coded actions with the hand whereas others only coded actions with the tool.

"Being able to decode desired tool use behaviours from brain signals takes us one step closer to using those signals to control those same types of actions with prosthetic limbs," says Dr. Gallivan. "This work uncovers the brain organization underlying the planning of movements with the hand and hand-operated tools and this knowledge could help people suffering from spinal cord injuries."

The research was recently published in *eLife*.

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