Robot model for infant learning shows bodily posture may affect memory and learning

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A robot is taught to distinguish between two objects as part of the research on the effect of body posture on infant learning. Credit: University of Plymouth

An Indiana University cognitive scientist and collaborators have found that posture is critical in the early stages of acquiring new knowledge.

The study, conducted by Linda Smith, a professor in the IU Bloomington

College of Arts and Sciences' Department of Psychological and Brain Sciences, in collaboration with a roboticist from England and a developmental psychologist from the University of Wisconsin-Madison, offers a new approach to studying the way "objects of cognition," such as words or memories of physical objects, are tied to the position of the body.

"This study shows that the body plays a role in early object name learning, and how toddlers use the body's position in space to connect ideas," Smith said. "The creation of a robot model for infant learning has far-reaching implications for how the brains of young people work."

The research, "Posture Affects How Robots and Infants Map Words to Objects," was published today in *PLOS ONE*, an open-access, peer-reviewed online journal.

Using both robots and infants, researchers examined the role bodily position played in the brain's ability to "map" names to objects. They found that consistency of the body's posture and spatial relationship to an object as an object's name was shown and spoken aloud were critical to successfully connecting the name to the object.

The new insights stem from the field of epigenetic robotics, in which researchers are working to create robots that learn and develop like children, through interaction with their environment. Morse applied Smith's earlier research to creating a learning robot in which cognitive processes emerge from the physical constraints and capacities of its body.

"A number of studies suggest that memory is tightly tied to the location of an object," Smith said. "None, however, have shown that bodily position plays a role or that, if you shift your body, you could forget."

To reach these conclusions, the study's authors conducted a series of experiments, first with Morse's robots, which were programmed to map the name of an object to the object through shared association with a posture, then with children age 12 to 18 months.

In one experiment, a robot was first shown an object situated to its left, then a different object to the right; then the process was repeated several times to create an association between the objects and the robot's two postures. Then with no objects in place, the robot's view was directed to the location of the object on the left and given a command that elicited the same posture from the earlier viewing of the object. Then the two objects were presented in the same locations without naming, after which the two objects were presented in different locations as their names were repeated. This caused the robot to turn and reach toward the object now associated with the name.

The robot consistently indicated a connection between the object and its name during 20 repeats of the experiment. But in subsequent tests where the target and another object were placed in both locations—so as to not be associated with a specific posture—the robot failed to recognize the target object. When replicated with infants, there were only slight differences in the results: The infant data, like that of the robot, implicated the role of posture in connecting names to objects.

"These experiments may provide a new way to investigate the way cognition is connected to the body, as well as new evidence that mental entities, such as thoughts, words and representations of objects, which seem to have no spatial or bodily components, first take shape through spatial relationship of the body within the surrounding world," Smith said.

Smith's research has long focused on creating a framework for understanding cognition that differs from the traditional view, which

separates physical actions such as handling objects or walking up a hill from cognitive actions such as learning language or playing chess.

Additional research is needed to determine whether this study's results apply to infants only, or more broadly to the relationship between the brain, the body and memory, she added. The study may also provide new approaches to research on developmental disorders in which difficulties with motor coordination and cognitive development are well-documented but poorly understood.

More information: *PLOS ONE*, dx.plos.org/10.1371/journal.pone.0116012

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