Pigeons can discriminate both space and time

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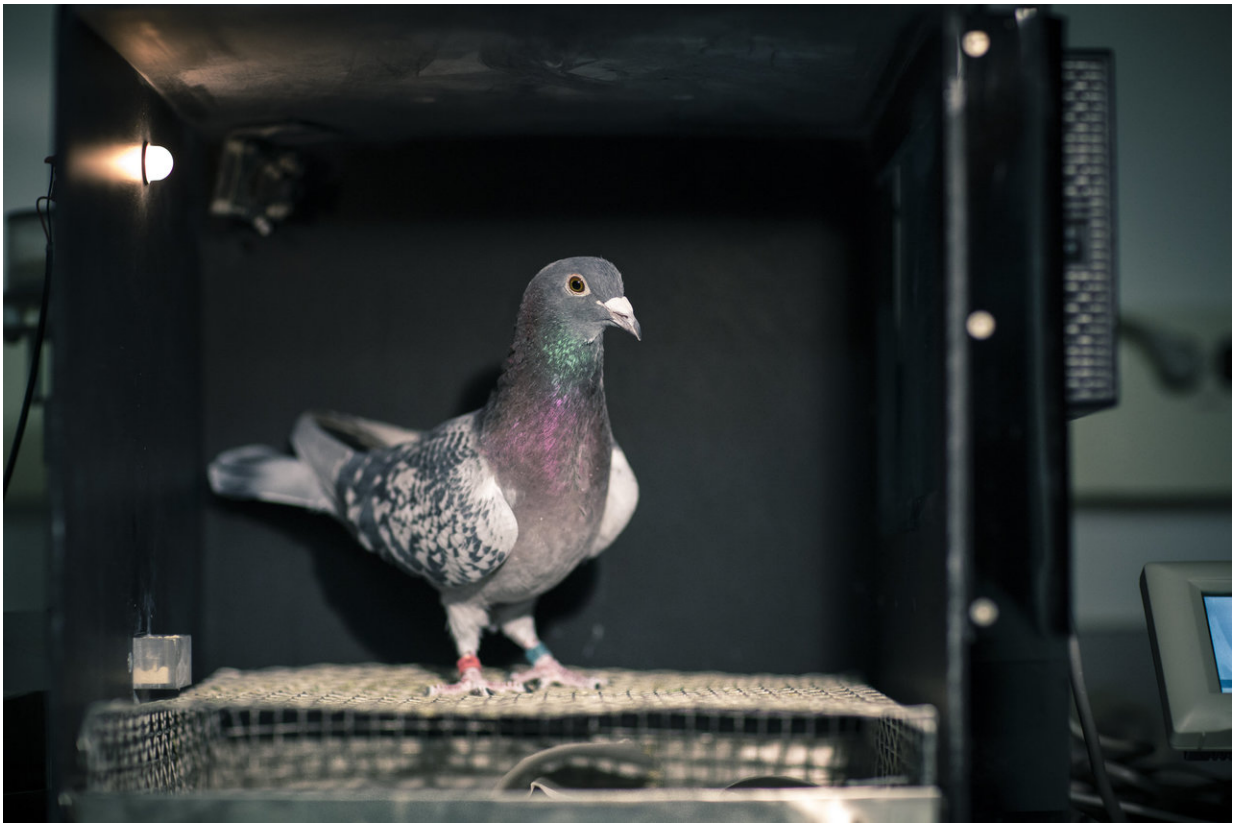

New research at the University of Iowa shows that pigeons can discriminate the abstract concepts of space and time -- and seem to use a region of the brain different from humans and primates to do so. The finding adds to growing recognition in the scientific community that lower-order animal species -- such as birds, reptiles, and fish -- are capable of high-level, abstract decision-making. Credit: Kathryn Gamble

Pigeons aren't so bird-brained after all. New research at the University of Iowa shows that pigeons can discriminate the abstract concepts of space and time—and seem to use a different region of the brain than humans and primates to do so. In experiments, pigeons were shown on a computer screen a static horizontal line and had to judge its length or the amount of time it was visible to them. Pigeons judged longer lines to also have longer duration and judged lines longer in duration to also be longer in length.

What that means, says Edward Wasserman, Stuit Professor of Experimental Psychology in the Department of Psychological and Brain Sciences at the UI, is pigeons use a common area of the brain to judge space and time, suggesting that these abstract concepts are not processed separately. Similar results have been found with humans and other primates.

The finding adds to growing recognition in the scientific community that lower-order animal species—such as birds, reptiles, and fish—are capable of high-level, abstract decision-making.

"Indeed, the cognitive prowess of birds is now deemed to be ever closer to that of both human and nonhuman primates," says Wasserman, who has studied intelligence in pigeons, crows, baboons, and other animals for more than four decades. "Those avian nervous systems are capable of far greater achievements than the pejorative term 'bird brain' would suggest."

Humans are able to perceive space and time, even without the aid of inventions such as a watch or a ruler. The region of the brain that helps humans make those abstract concepts more tangible is the parietal cortex , part of the cerebral cortex and the outermost layer of the brain. The cerebral cortex is known to be a locus of higher thought processes, including speech and decision-making, and the four lobes that comprise

it, including the parietal cortex, process different types of sensory information.

But the pigeon brain doesn't have a parietal cortex, or at least one developed enough to be distinct. So, the birds must employ another area of the brain to discriminate between space and time—or perhaps there's a common evolutionary mechanism in the central nervous system shared by early primates and birds.

Wasserman and his team wanted to find out.

They put pigeons through a series of tasks called the "common magnitude" test. Put simply, the birds were shown on a computer screen a horizontal line either 6 cm or 24 cm long for either 2 seconds or 8 seconds. If they correctly reported (by pecking one of four visual symbols) the length or the duration of the line, they received food.

The test then became more nuanced. The researchers introduced additional line lengths, thus adding greater variability in judging whether a line was short or long; they also presented the line to the pigeons for either a shorter or longer duration.

"The task now forces pigeons to process time and space simultaneously because they cannot know on which dimension they're going to be tested," Wasserman says.

The researchers found that the length of the line affected the pigeons' discrimination of line duration, and the duration of the line affected the pigeons' discrimination of line length. This interplay of space and time paralleled research done with humans and monkeys and revealed the common neural coding of these two physical dimensions. Researchers previously believed that the parietal cortex was the locus of this interplay. However, because pigeons lack an apparent parietal cortex,

Wasserman's findings suggest this isn't always the case.

The paper, "Non-cortical magnitude coding of space and time by pigeons," was published online Dec. 4 in the journal *Current Biology*.

Benjamin De Corte, a third-year graduate student with the UI's Iowa Neuroscience Institute and the Department of Neurology who helped design and execute the experiments, says the results show pigeons process space and time in ways similar to humans and other primates.

"The cortex is not unique to judging space and time," says De Corte, who is first author on the paper. "The pigeons have other brain systems that allow them to perceive these dimensions."

Victor Navarro, a UI graduate student in Wasserman's lab, helped design and carry out the experiments and is a contributing author on the paper.

Provided by University of Iowa

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