

Study uncovers surprising things about squirrels

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As the squirrel rotates a nut between its front paws, its brain is considering a variety of factors to reach the answer to a critical question: Do I eat this nut now, or do I store it for later?

That's one of the conclusions of the most comprehensive study of the squirrels' decision-making process—research that revealed that their behaviors are far more intricate than the casual observer realizes.

An analysis of [fox squirrels](#) on the campus of the University of California, Berkeley, by psychologist Mikel Delgado found that the rodents consider several variables when deciding whether to store food, or save it for later. Squirrels assess the characteristics of food they find, such as its perishability and nutritional value. They also consider the availability of food at that time and the presence or absence of competitors.

"What's cool is that these animals are solving problems right under our feet and most people don't realize it," said Delgado, whose Ph.D. dissertation was on the complexity of [squirrel](#) behavior.

Delgado, a Maine native, said she has always been obsessed with animals and was interested in better understanding what they do instinctively in the wild. She has a background in cognition, which deals with problem-solving, memory and thinking, and had worked with pigeons and zebrafish. For her graduate work, she wanted to study the behavior of animals living in their natural environment. She also wanted to do

research that would help people understand that animals—different as they are from humans—have complicated problems to solve.

She figured that squirrels are ubiquitous for most people, so studying them seemed like a good choice. Besides, the animals are abundant on college campuses. While some people might find them annoying, many find their bold behavior appealing.

She chose to study the larger fox squirrels, which are more comfortable in the open and therefore easier to observe, rather than the smaller gray squirrels, which prefer more cover.

To better understand how the squirrels make caching decisions, she conducted a series of experiments using basic equipment. For identification, squirrels were marked with a nontoxic dye that disappears with molting.

Delgado and her undergraduate helpers, armed with various nuts, stopwatches, camcorders and GPS trackers, followed fox squirrels around campus, studying their behavior. They focused, in particular, on a population in the northwest corner of campus, near the intersection of Hearst Avenue and Oxford Street.

Undergraduate assistant Simon Campo spent 2 1/2 years helping the research lab. He said the different personalities of the squirrels sometimes made the field work challenging.

"They're pretty mischievous," Campo said. "They go up on roofs, in bushes, up trees and jump from tree to tree. They were definitely hard to track at times; some squirrels were more so than others."

Caching food for future use is important for survival for all species when food is scarce. They use one of two strategies: larder hoarding or scatter

hoarding.

Larder-hoarding animals put large amounts of food in one spot that they must defend, while scatter-hoarding animals, such as some songbirds and Delgado's squirrels, hide their food in different places.

"Scatter hoarding is an interesting adaptation because it's basically not putting all your eggs in one basket," said Suzanne MacDonald, a psychology professor at York University in Toronto who studies animal behavior. "You make sure that you've got little bits everywhere so that at least some of them will remain and you can rely on that to get you through the hard times."

In one experiment, Delgado tested how squirrels assess food when provided nuts of different values. She presented participating squirrels with a specific order of hazelnuts and peanuts and observed the following behaviors for each nut: the number of head flicks, the time manipulating the nut with the paw, the time until the nut was eaten or cached, the number of incomplete caches before a successful cache and the time spent covering a cached nut.

Turning a nut around in their paws serves multiple functions. It helps the squirrels assess the integrity of the nut and spot any holes or cracks in the shell. Imperfections could indicate the nut is more susceptible to rot. They also might be the best entry points for breaking into the shell.

Manipulating the nut also lets squirrels determine the shape and weight of the nut, which helps them figure out the best way to carry it.

The other main assessment behavior is the head flick, a rapid rotation of the head. Squirrels tended to head flick more when assessing hazelnuts, which they cached more often than the peanuts. But they reduced that behavior in the presence of other squirrels. Head flicking may alert

competitors of cacheable food, so it may be wise not to draw attention to a food item a squirrel wants to store and eat later.

Delgado's experiments were conducted in the summer and fall. Food is more abundant in the fall.

"In the summer, they're definitely taking more time to handle the nuts before they bury them, so that suggests to us that when the food is scarce, every decision is a little bit more important," Delgado said.

In one experiment, she found that the squirrels would basically arrange their caches by food type in a strategy called "chunking." She presented the squirrels with four different types of tree nuts—almonds, hazelnuts, pecans and walnuts—and examined the distances and patterns of the nuts once cached.

People may use chunking in pantries when they place all food items of a certain type or use, such as baking ingredients, on the same shelf. By using such a system in their caching, squirrels employ a memory tool.

"It's really interesting to see that different brains solve the same problem in different ways and that evolution is extraordinary for preparing brains to deal with what environmental conditions they live in," MacDonald said.

While researchers previously thought squirrels use chunking, Delgado's work was the first documentation of it.

Other squirrel experts welcomed the insights of her work.

"We're beginning to understand how sophisticated these animals are in making decisions when they are caching," said Michael Steele, co-author of "North American Tree Squirrels" and a biology professor at Wilkes

University in Pennsylvania.

Delgado hopes her research on the cognitive ability of the fox squirrel will help people appreciate squirrels more.

"Animals are as smart as they need to be, including humans," she said.

"They have evolved to solve a particular type of problem, and for squirrels that problem is storing [food](#) and finding it later. They are really good at that problem."

MacDonald agreed. "Why would a squirrel need to have a primate brain? If it did, it would be a primate. Squirrels are squirrels, and we should go, 'Awesome! Love the squirrels!'"

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