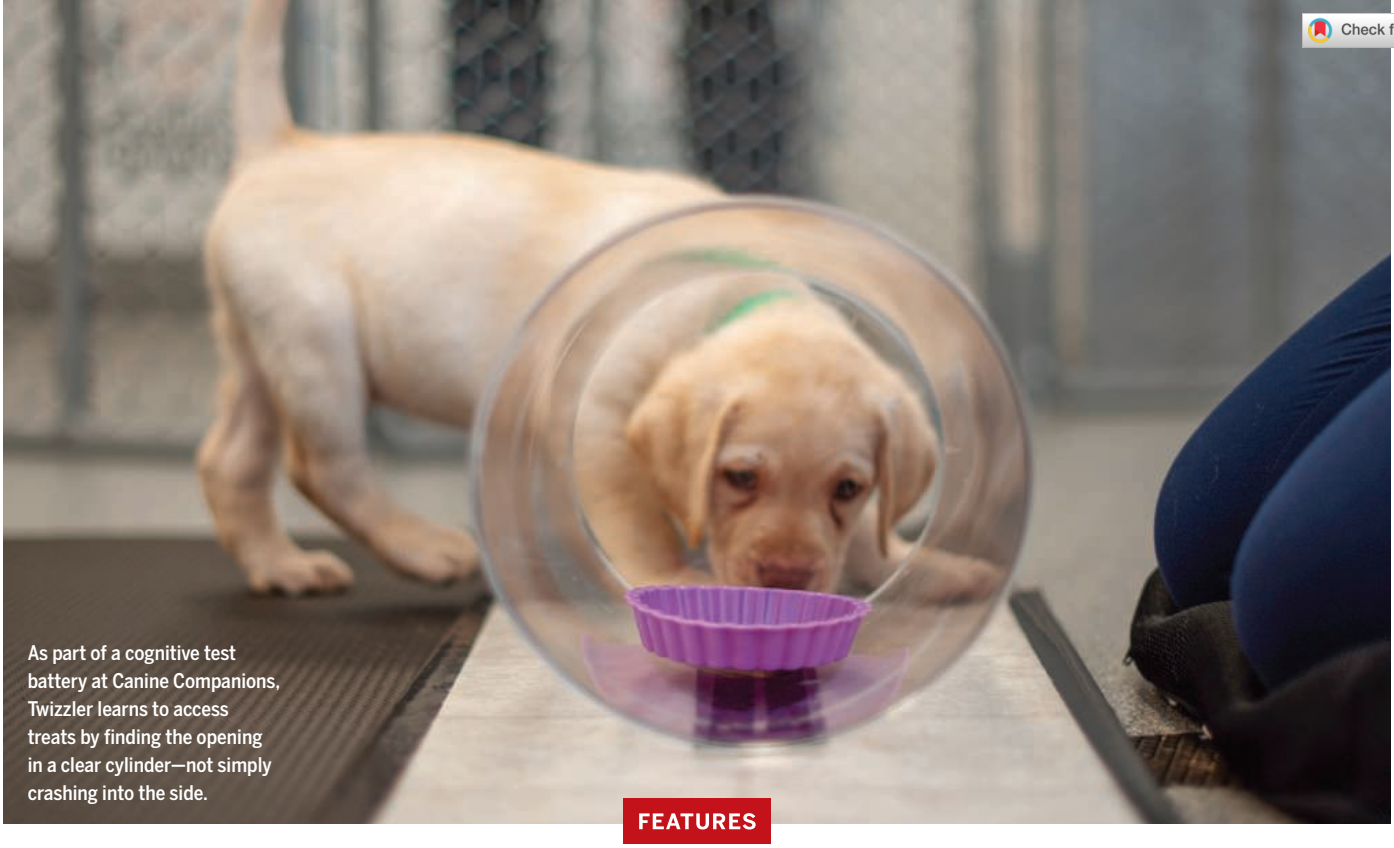

As part of a cognitive test battery at Canine Companions, Twizzler learns to access treats by finding the opening in a clear cylinder—not simply crashing into the side.

FEATURES

BUILDING A BETTER WORKING DOG

More than half of canines trained to help people with disabilities fail to graduate. Can science help? **DAVID GRIMM**, in Santa Rosa, California, and Patterson, New York

On a grassy campus about an hour north of San Francisco, a group of dogs has just started graduate school. Five Labrador–golden retriever mixes wearing blue vests sit on cots in the back of a large, open room, waiting patiently to show the world what they can do. The walls are covered in blocky stenciled commands—"SIT," "STAY," "LIE DOWN"—but these canines are capable of far more than that.

A trainer sits in a wheelchair in the center of the room, and a black dog named Gilson II ambles over. The trainer says "tug," and Gilson chomps a yellow rope attached to the chair and pulls the person across the room. When the duo reaches the wall, the trainer says "switch," and the dog bops a light switch with her nose. Next, Gilson opens a medication drawer, fetches a laundry basket, and retrieves a set of dropped keys. After each task, she looks up at her trainer with softly pleading eyes, as if to say, "Was that OK?" It was, and Gilson gets a treat.

Here at Canine Companions—one of the world's largest working dog organizations—Gilson and her pals are being transformed from adorable pups into adorable pups with a purpose. After nearly 2 years of basic instruction, they've entered the specialization phase of their careers, where they'll try to master skills designed to make life easier for people with more than 60 disabilities, from muscular dystrophy to Down syndrome.

Paprika II, a sweet yellow canine, is learning to assist children with autism by covering them like a weighted blanket to help them calm down. When a trainer puts her head in her hands and begins to nervously jiggle her leg, an attentive black dog named Jocelyn II nudges her, a skill designed to interrupt anxious behaviors in veterans with post-traumatic stress disorder. And in a dormitory building next door, a very licky Nakita I is studying to be a hearing dog, leading her trainer to a door when a bell rings and rousing him out of bed when a fire alarm blares.

Yet more than half of pups like these never graduate. Health problems including elbow and hip dysplasia fell some; others are cut for behavioral reasons such as a lack of impulse control. "We call that one the squirrel phenomenon," smiles Brenda Kennedy, Canine Companions's chief veterinary and research officer.

The need for these animals is greater than ever. Millions of people with disabilities suffer in ways that could be alleviated by service dogs—a class of working canine that includes guide dogs and the types of pups Canine Companions trains, but not emotional support animals or military or police dogs. Yet there are only about 40,000 service dogs in the world, and the more than 200 organizations that breed and train them, at a cost of tens of thousands of dollars per animal, struggle to keep up with demand. "Our pipeline is our greatest

PHOTO: COURTNEY UNGER/CANINE COMPANIONS

challenge," Kennedy says. "We've sometimes had to close our waitlist because it's too long."

New science could help. "Cognitive test batteries" are harnessing the latest insights into the canine mind to better predict which pups will make it, and which jobs they'll be best suited for. Meanwhile, so-called estimated breeding values—long used by the livestock industry to improve milk and meat production—are being infused with canine genomics, paving the way for working dog organizations to optimize their animals, sometimes before they're even born. If the efforts bear fruit, they could help ensure that more, and better, working dogs graduate—and make it into the hands of the people who need them most.

WITH HIS STUBBY LEGS, droopy tail, and penchant for peeing on the floor, Twizzler may not seem like the future of working dog science. But this yellow, 8-week-old Lab-golden puppy holds clues that could guide the field forward. Organizations like Canine Companions have long administered a behavior checklist to gauge dogs' potential and what type of additional training they need. But the scores—rating everything from anxiety to excessive humping—are subjective, and it's not clear which are tied to future success.

"It's a bit like trying to predict which kindergartners will grow up to be brain surgeons," says Brian Hare, an evolutionary anthropologist who runs the Canine Cognition Center at Duke University. For the past 15 years, Hare's team has been developing a cognitive test battery for dogs—a set of scientifically rigorous challenges that are more objective and predictive.

That's where Twizzler comes in. Here at Canine Companions he's part of a research project run by Emily Bray, a cognitive psychologist at the University of Arizona who got her start in Hare's lab. For the past 8 years, she's been collecting genetic, environmental, and behavioral data on hundreds of dogs like Twizzler in hopes of improving the predictive powers of cognitive test batteries.

First up is the "impossible task." Bray places a plastic container in front of Twizzler and drops a couple treats inside. Then she seals the lid on tight. Unlike most species, dogs give up quickly and look to humans for help. Twizzler is no different. He stares beseechingly into Bray's eyes—a full 5 seconds, according to tracking glasses she's wearing—and whines. That's a good sign, she says: Pups that make more eye contact, her work has shown, are more likely to graduate.

Next, Bray places a clear trashcan on its side and puts some kibble in the middle. Twizzler quickly learns to find the opening instead of crashing into the side of the cylinder, as some pups do. That's a mark of impulse control, Bray says, something working dogs must master in a world full of distractions.

In a final test, Bray introduces Twizzler to a FurReal Friend, a motorized orange cat that walks, mews, and purrs—a noise that, thanks to the toy's advanced age, sounds more like it's hacking up a rusty hairball. Twizzler is unfazed, scampering up to the cat, sniffing its butt, and chewing its tail. "That's definitely on the boldest end of the spectrum," Bray laughs. Bold pups tend to be confident adults, and the trait may be one of the best predictors of guide dog success. "What a good boy!" Bray says. Twizzler squats on the floor and pees.

Bray's work is still in its early stages. But her research is already shedding light on the canine mind, revealing, for example, that dogs' sensitivity to human communication emerges soon after birth. It's also showing that many of the differences in cognition between dogs that appear early in life persist throughout adulthood.

Bray hopes that within a couple years, cognitive test batteries could spit out a master score that would tell working dog organizations which pups are most likely to graduate, and more granular scores that would help schools optimize their training and slot dogs into the best job tracks. "That's the holy grail of this type of work," Hare says.

But what if schools could predict a pup's chances of success before it was even born?

IN A RURAL TOWN north of New York City, a black Lab puppy with wide, worried eyes is navigating an obstacle course. Staff at Guiding Eyes for the Blind—one of the largest guide dog schools in the United States—have scattered a variety of objects across the floor of a large room: a miniature white staircase, a black plastic tunnel, a gray bucket, and various chew toys. Like Twizzler, this dog, named Ivan, is a tinkler. But unlike that bold pup, Ivan seems frightened of everything around him.

Wearing a bright red vest fitted with sensors, Ivan approaches each object gingerly, touching some with his nose and backing away. Unexpected noise—an umbrella popping open, a vacuum cleaner roaring to life, or a cookie tin clattering to the floor—sends him running up the little staircase, where he perches on top. "That's their safety spot," says Jane Russenberger, the school's former director of breeding and genetics. The longer the testing goes on, the more timid Ivan becomes, and the more time he spends on top

At Canine Companions, Brenner II is learning to help people in wheelchairs (here, trainer Sarah Brinck) by pulling them across rooms and turning on light switches.

PHOTO: COURTNEY UNGER/CANINE COMPANIONS

of the stairs. "He's kind of going downhill," she says.

At Guiding Eyes, scientists aren't just interested in what Ivan's performance says about him—they're interested in what it says about his parents and future offspring. Should mom and dad continue to breed? Should Ivan be allowed to? "The secrets," Russenberger says, "are in the puppies."

Russenberger joined Guiding Eyes in 1988, hoping to improve its breeding program. At the time, trainers were using vague and subjective criteria to figure out which dogs to mate. "They had classifications like 'pepperpot' and 'soft sour stubborn,'" (for strong and weak initiative, respectively) she says. "The categories were terrible." Schools just hoped for the best, largely with disappointing results. When Russenberger started at Guiding Eyes, only one in five puppies became a successful guide dog.

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>
> **Brenda Kennedy**
> Canine Companions

Things changed in the early 1990s, when she heard an animal geneticist named Eldin Leighton give a talk about something called estimated breeding values (EBVs)—statistical calculations based on pedigree, along with health or behavioral data. They estimate the likelihood on a scale from negative one to one that an animal will pass on a trait of interest to the next generation. Leighton had ported the approach over to guide dogs from his work in the livestock industry, which uses EBVs to improve traits including milk production and meat quality, and he helped Russenberger begin to implement them at Guiding Eyes in 2003.

She initially focused on two health problems: hip and elbow dysplasia, which can lead to limping and stiffness and are a major reason animals fail out of guide dog programs. By consistently breeding dogs that had higher EBV scores for elbow and hip quality than their parents, Russenberger says she reduced the incidence of the two conditions to "almost nothing" in about 10 years. She has also used EBVs to cut down on other detrimental traits, including epilepsy and harness sensitivity. Now, about half of all Guiding Eyes puppies become successful guide dogs. But Russenberger wants to boost the success rate even higher.

A big target in her sights is behavior. Even if working dogs graduate, they can develop crippling behavioral issues that force them to retire early. Rebekah Cross knows that heartbreak firsthand. Her first guide dog, a spunky yellow Lab named Jingles, developed anxiety when she was 3 years old. "Every time I sneezed, she would freak out," says Cross, Guiding Eyes's director of donor relations. "Then she became afraid of riding in cars and walking down certain streets. It was all too much for her." Jingles had to be retired before she was 5 years old. "You've given your heart to them. They've kept you safe. And now suddenly, they can't work," Cross says. "It can be really hard emotionally."

Studies on dogs like Ivan could help. As the puppy navigates the obstacle course, staff score him on a variety of behaviors, from focus to fear of new objects. His red vest, meanwhile, tracks his movement and heart rate, beaming data to a nearby laptop. These and other measurements feed into the 18 health and behavioral EBVs Guiding Eyes currently tracks, from skin health to "resilience," where Ivan scores especially low. All that time he spends on top of the staircase reflects difficulty recovering from stress, which in guide dogs leads to trouble learning and following cues. "It's a key reason they don't make it," Russenberger says.

Ivan's EBVs don't just apply to him. They're also used to recalculate the EBVs of his parents. If mom and dad are producing a bunch of timid pups, it may be time to find them different partners—or stop breeding them. Unlike with cognitive test batteries, Russenberger says, the goal isn't to predict which puppies will have problems—"it's to prevent those puppies from being born in the first place."

The more data that are collected—from Ivan, his siblings, and even more distant relatives—the more predictive all of their EBVs become. But genetics could make EBVs even stronger.

DOWNSTAIRS from the puppy testing arena lies the Cryogenics & Reproduction Suite, a room containing microscopes, computers, and four liquid nitrogen tanks filled with dog semen. Here, Russenberger logs into a database that she, Leighton, and others have been building for more than 30 years. Known as the International Working Dog Registry (IWDR), it's a massive repository of detailed health, behavior, and genealogy information on more than 100,000 working dogs from 23 countries. EBVs are only as good as the data that feed them, and the database is the largest of its kind ever created—a pedigree to end all pedigrees.

With it, organizations are no longer stuck with their own small breeding stock; they can search across the world for mates that have the EBVs they're most interested in. "There's no genetic progress being made if you're breeding the same dogs over and over," says Russenberger, who retired from Guiding Eyes in 2021 but still consults for the school and helps run the database. The registry also enables organizations to mate their dogs with canines that have long since passed away—hence the cryogenic tanks—and it flags when a pair is too closely related, helping avoid the inbreeding problems that have long plagued the field.

Even at their best, however, behavioral EBVs rely on largely subjective data. And because most of the information that feeds into the health-related scores is collected in the first 2 years of life, they have trouble predicting late-onset diseases such as hemangiosarcoma, an aggressive blood vessel cancer estimated to kill nearly 90% of afflicted dogs within 1 year. "You don't even know something's wrong until your dog collapses on the floor," says Frances Chen, a geneticist at the University of Massachusetts Chan Medical School (UMass Chan). "It's like a time bomb waiting to go off."

Chen hopes to tackle those problems with genomically enhanced EBVs (GEBVs). Most behaviors and diseases are shaped by hundreds or even thousands of genes and environmental factors—patterns that traditional pedigree-based EBVs can't fully account for. GEBVs use DNA markers spread across a dog's entire genome to estimate how much inherited risk the animal actually carries. Adding DNA markers also clarifies just how related dogs are to each other, leading to more accurate predictions for a given trait.

Chen's preliminary modeling and real-world data suggest GEBVs could be twice as accurate as EBVs, revealing associations that otherwise might take multiple litters to uncover. "You'd be saving organizations

Ivan dons an electronic vest (top) before navigating an obstacle course at Guiding Eyes for the Blind (bottom). His physiological and behavioral data will be used to calculate "estimated breeding values" that indicate how likely he is to pass on particular traits. Those values could determine whether he is one day allowed to sire pups.

PHOTOS: ZOE BENNETT/GUIDING EYES

tons of time, money, and heartache," Russenberger says. Chen has collected data on 1000 dogs so far and is hoping to publish a paper this year on the predictive value of GEBVs for hemangiosarcoma.

But as with EBVs, more data are needed to help GEBVs reach their full potential—perhaps tens of thousands of genomes, Chen estimates. Even the biggest guide dog school in the world breeds fewer than 1500 puppies a year, however. So, she's spearheading the Working Dog Project, a joint venture with the Broad Institute, UMass Chan, and the community science nonprofit Darwin's Ark. Together with IWDR, the effort has already gathered data on more than 50,000 dogs—contributed by working dog organizations, academic researchers, and pet owners around the world.

There are still many hurdles to overcome. Given the complexity of canine behavior and genetics, it's unlikely that any approach—including cognitive test batteries and GEBVs—can dramatically increase the efficiency of the working dog pipeline, says Ádám Miklósi, a cognitive ethologist at Eötvös Loránd University and leading expert on canine cognition. "Maybe you can reduce dropout rates 20% to 30% at most." He also worries that trying to optimize dogs too much for any one trait will cause others to suffer. As he's fond of telling his students, "If you concentrate 100% on mathematics, you will be killed crossing the road."

Back at Canine Companions, Kennedy says she'd be happy with even a modest improvement in graduation rates. "Getting to 60% or 65% would make a huge difference," she says. "That means utilizing our resources better and placing more dogs with more people."

In the evaluation room where Twizzler the puppy faced the robotic cat and other trials, a nearly 2-year-old Lab-golden mix named Traci VI is facing the same challenges. Like Twizzler, she spends a lot of time looking up at Bray. "It's very communicative," Bray says. "That's what we're looking for." Kennedy gazes at the soon-to-be graduate with approval. "I have no doubt she's going to make a great service dog," she says. "I think she's going to do well." □

Building a better working dog

David Grimm

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