BRED TO BE BEST

The Brain-Behavior Link

What makes a border collie instinctually suited to herding sheep, a German shepherd perfect for police work, or a beagle superb at following a scent? Ever since the domestication of a Pleistocene wolf some 14,000 or more years ago, humans have played a decisive role in the evolution of dogs. First bred for tameness, dogs since then have been selected to perform many specialized tasks, such as pointing to prey, or guiding the blind. Could study of modern dog breeds shed light on how brains evolve in response to selection pressure on behavior?

Erin Hecht, an assistant professor in the department of human evolutionary biology, wondered if breeds’ specialized behavioral adaptations and abilities might be visible as neuroanatomical changes. When she compared MRI scans of 62 purebred pet dogs of 33 unique breeds, she saw noticeable patterns of difference.

In fact, she discovered six networks of brain regions that covary (change together), each associated with breeding for specific behaviors, such as sight hunting, scent hunting, guarding, and companionship. For example, in dogs that hunt by sight, she found differences in a network of brain regions involved in visual perception and navigation. “We think,” she says, “that might be related to visually tracking a bird or whatever the hound is following.”

Dogs’ skulls come in all sizes and shapes: some are large, some are long and narrow, and some are very small. But Hecht found that while brain size, body size, and skull shape do influence brain anatomy, there are also additional neuroanatomical differences across breeds over and above these factors.

Hecht and her colleagues published these results in the *Journal of Neuroscience* last September, together with a phylogenetic analysis of the modern dog breeds’ family tree. This established that the differences in brain structure among breeds could not be explained by deep ancestry. Instead, in separate branches of the tree, selection pressure for specific behavioral traits, likely within the past 200 years, led to the simultaneous emergence of particular networks of brain structures—thus, scent dogs from different branches of the family tree shared similar anatomical differences.

Hecht first became interested in studying the evolution of canid brains when she learned about a well-known experiment in Siberia to breed wild silver foxes to become either tame or aggressive. Since 1959, the tamest foxes—initially selected for how close they would allow a human to get before running away—have been studied in Novosibirsk, to learn whether selection for tameness might also have driven traits such as the floppy ears, wavy hair, and curly or shortened tails shared by many domesticated breeds. Sixty years into the experiment, says Hecht, the tamest foxes now react to people by wagging their tails. “They lick, they whimper, and seem overjoyed with the prospect of human contact.”

But surprisingly little research had investigated changes in their brains, as work by
Dog breeds’ specialized behavioral adaptations and abilities are clearly visible as neuroanatomical changes.

are in the limbic system and the prefrontal cortex,” Hecht explains. “The limbic system governs instinctual emotional reactions, the fight or flight response, and aspects of social behavior that are cued by scents, while the prefrontal cortex regulates volitional types of behavior, as well as more complex aspects of social behavior like interpreting social signals and deciding what types of social signals to send in return. That’s where we’re seeing changes so far in the foxes.”

Intriguingly, though, in dog brains the morphologies related to tameness are not as clearly discernible, and Hecht says that a continuing behavioral study suggests that dogs are not as friendly as the tame foxes. First-year doctoral student Sophie Barton says she was “completely shocked by this—we expected the dogs to run to the front of the cage...when a stranger walked in..., but instead they adopted a wait-and-see approach,” acting neither aggressive nor friendly until they could discern the human’s intentions. Barton thinks that difference may have evolved as a result of dogs having lived in a complex human environment—and with very different selection pressures during the past 200 years of intensive breeding. Although tameness is an important part of the initial stage of domestication, she says, the trait “can definitely be manipulated in later stages.”

Hecht and Barton are particularly interested in what these studies may reveal about the plasticity of the brain: how innate adaptations for a particular skill interact with acquired experience to shape neuroanatomy. The human brain, for example, has adaptations for acquiring language that are activated when listening to other people talk. A similar “experience-expectant plasticity” underpins skill behavior in working dogs, says Barton. Through the lab’s project website, caninebrains.org, she is recruiting dogs from working (herders and livestock guardians) and hunting breeds (retrievers, flushers, and pointers) with nonworking siblings, in order to study the neural changes caused by training and experience.

“We know that training is doing something,” says Hecht. “We’re trying to figure out how far an innate genetic inheritance gets you. And then, what’s the additional bump that you’d get from experience and learning?” In parallel work with humans, she and another postdoctoral researcher, Sujas Vijayakumar, are tracking how brains change when people acquire paleolithic toolmaking skills, crucial during a large part of human evolutionary history, and comparing those shifts to brain changes seen in undergraduates learning computer programming.

For now, Hecht and Barton hope to establish the dog as a model for evolutionary neuroscience, for learning how structures within the brain evolve and how the brain balances innate adaptations with propensities for plasticity. “I believe a lot of questions can be answered with these animals,” says Barton, “because we know what selection pressures they underwent to develop various skills and different types of behaviors.” Ultimately, the brains of dogs may reveal just as much about the brains of their masters. ~ jonathan shaw

ERIN HECHT WEBSITE: projects.iq.harvard.edu/evolutionaryneurosciencelab/home

CONSTITUTIONAL QUESTIONS

The Extinction of the Press?

WHEN AMERICA’S FOUNDERS drafted the First Amendment, including its protection of a free press as key to self-governance, they could not foresee the twenty-first-century media landscape: Twitter and Facebook, filter bubbles that feed readers stories that reinforce their beliefs, and the shrinking number of local newspapers, now considered “legacy” media.

Dwindling access to reported news threatens to undermine democracy, warns former Law School dean and 300th Anniversary University Professor Martha Minow. “Newspaper newsrooms lost 45 percent of their employees between 2008 and 2017,” she says. “And since the start of the pandemic, there is a cascading set of reductions and cutbacks in [news] production, which is ironic...when people are so eager and desperate for news.”

Compounding the problem are a growing number of “news deserts”: communities where there are no longer media outlets sending reporters to city-council meetings, to monitor how tax dollars are spent, or to ask local public-health officials about their response to COVID-19. Minow once met one of the whistleblowers who exposed the problem of lead in the water in Flint, Michigan. “She said to me, ‘There are many Flints all over the country, and the difference was that in Flint there was some news media.’”

As social-media platforms become a predominant news source, “Professional journalism, messages from your cousin, or messages from a Macedonian adolescent paid to design arresting ads can seem equal,” Minow wrote in a recent article published in the Loyola Law Review. There’s no human editor vetting the news, or ensuring that content meets journalistic standards. And unlike newspapers, in which a reader might head first for the sports page but encounter topics such as business or politics along the way, social-media sites such as Facebook deliver highly curated content based on read-