The Genius *of* Dogs

Discovering the Unique Intelligence of Man's Best Friend

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and

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For all dogs

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PREFACE

When we brought our new baby home from the hospital, our dog Tassie was faced with a dilemma. Since the day we adopted him from a shelter as a puppy, Tassie has had a basket of stuffed toys. Growing up, his favourite activity was to rip out the stuffing and leave it all over the house. Every now and then we would fill up the basket with new toys he could rip up all over again.

We also gave our baby, Malou, a basket of stuffed toys, which was almost identical to Tassie's. As Malou started to crawl, she quickly developed the habit of dragging the toys out of her basket and leaving them all over the house.

Here was the dilemma. Of the dozens of toys, Tassie had to figure out which ones were his to rip up, or Malou was going to find her favourite toys in a heap of stuffing and there would be trouble.

Tassie turned out to be rather good at it. Of course, we were hopeful Tassie would have this ability, since Brian's colleague at the Max Planck Institute for Evolutionary Anthropology in

Germany, Juliane Kaminski, studied a dog named Rico who had solved a similar problem. Kaminski received a phone call one day from a very nice German lady saying she had a Border collie who understood more than two hundred German words, mostly the names of children's toys. This was impressive but not unheard of. Language-trained bonobos, bottlenose dolphins, and African grey parrots have learnt a similar number of names for objects. What was different about Rico was *how* he learned the names of these objects.

If you show a child a red block and a green block, then ask for 'the chromium block, not the red block', most children will give you the green block, despite not knowing that the word *chromium* can refer to a shade of green. The child *inferred* the name of the object.

Kaminski gave Rico a similar test. She placed a new object Rico had never seen before in a different room with seven of his toys that he knew by name. Then she asked him to fetch a toy using a new word he had never heard before, like *Sigfried*. She did this with dozens of new objects and words.

Just like children, Rico inferred that the new words referred to the new toys.

Without any training, Tassie has never ripped up one of Malou's toys instead of his own. His toys and her toys can be lying in a jumble on the floor, and he will carefully extract his toys and play with them, giving her toys only a longing glance or a quick sniff. He adapted quicker than we did to life with a new baby.

In the last ten years, there has been something of a revolution in the study of canine intelligence. We have learnt more about how dogs think in the past decade than we have in the previous century.

This book is about how cognitive science has come to understand the genius of dogs through experimental games using nothing much more high-tech than toys, cups, balls, and anything else lying around the garage. With these modest tools, we have been able to peer into the rich cognitive world of dogs and how they make inferences and flexibly solve new problems.

Thinking about dog genius will not only help us enrich their lives but also broaden how we think about human intelligence. Many of the same concepts used to study dog intelligence are being applied to humans. Perhaps the greatest gift our dogs will give us is a better understanding of ourselves.

Everyone has an opinion about what makes dogs clever. There is now an extensive scientific literature examining dog psychology that sometimes supports or doesn't support these opinions. To help all dog lovers debate what the latest scientific findings might mean, this book provides a comprehensive review of dog cognition, or 'dognition'.

We have read thousands of scientific papers relevant to the study of dog cognition, and we reference more than six hundred of the most important and interesting of these papers in this book. If you are interested, there are ways to get access to these papers and read them for yourself.*

While our review is comprehensive, it covers only areas that have

* Most exciting is that much of the research we review is available to you online since: (1) Google has a function called Google Scholar where you can download many of the papers; (2) many scientific journals are more often allowing free access to their papers through their online sites; (3) you can search the website of the scientists who authored a paper to find a link to their publications, where you can download their papers for free; and (4) there is nothing that scientists like more than if you write to them and ask them for their papers. Hopefully, they will happily share if there is a paper we discuss in this book that you cannot get access to otherwise.

been studied scientifically. We may not cover some areas of interest simply because no scientist has published anything on the topic. But on the flip side, there is tons of fascinating research on dognition you may never have imagined.

Although we have done our best to represent the literature fairly, not every scientist will agree with everything we report. Whenever we could, we highlighted alternative perspectives or competing data in the main text. But for ease of reading, we have provided extensive notes at the back of the book that cover important details and alternative findings when they are available.

Disagreement and debate in science are healthy and exciting. Disagreement often drives research that leads to advances in our understanding. Scientists rely on scepticism and empirical debate as a road to the truth. So do not be alarmed if your intuition or your own observations lead you to be sceptical of some of the evidence we present. You are just being a good scientist.

We hope that when you finish this book, your new knowledge, combined with your own observations, will lead to interesting discussions and debates with your fellow dog lovers. Through these debates, we can learn how to have an even richer relationship with our dogs. We can also identify areas where we need more understanding or where scientists have not even asked the right questions. This is all part of the fun.

What we know for certain is that the cognitive world of every dog is far more complex and interesting than we thought possible. We also have a tantalizing glimpse into the secret of their success. We can now pinpoint the stuff of dog genius.

Brian had the good fortune to play a significant role in the unfolding of this story of discovery—as did his childhood dog Oreo.

Some of what is laid out in the following pages will shock even the most knowledgeable dog owners. It is not always obvious where dogs will show an ability to make inferences or show more flexibility than other species. But in the end, your intuition is correct—your dog *is* a genius.

Part One

Brian's Dog

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GENIUS IN DOGS?

The many flavours of genius

Can I really be serious about the title? Most dogs can do little more than sit and stay, and can barely walk on a lead. They are baffled when a squirrel disappears up a tree by circling the trunk, and most will happily drink out of the toilet bowl. This is not the profile of a typical genius. Forget Shakespearean sonnets, spaceflight, or the Internet. If I used the clichéd definition of genius, this would be a very short book.

I am serious, and hundreds of studies and the latest research back me up. This is because in cognitive science, we think about intelligence in animals a little differently. The first thing we look at, when judging the intelligence of animals, is how successfully they have managed to survive and reproduce in as many places as possible. In some species, such as cockroaches, success does not have much to do with intelligence at all. They are just very hardy and excellent reproducers.

But with other animals, surviving takes a little more intellect, and a very specific kind of intellect. For instance, it does not do any

good composing sonnets if you are a dodo. You are obviously missing the intelligence you need to survive (in the dodo's case, this was learning to avoid new predators such as hungry sailors).

With this as our starting point, the dog is arguably the most successful mammal on the planet, besides us. Dogs have spread to all corners of the world, including inside our homes, and in some cases onto our beds. While the majority of mammals on the planet have seen a steep decline in their populations as a result of human activity, there have never been more dogs on the planet than today. In the industrialized world, people are having fewer children than ever but are simultaneously providing an increasingly lavish lifestyle for a growing population of pet dogs. Meanwhile, dogs have more jobs than ever. Service dogs assist the mentally or physically disabled, military dogs find bombs, police dogs do guard duty, customs dogs detect illegally imported goods, conservation dogs find scat to help estimate population sizes and movements of endangered animals, bedbug dogs detect when hotels have a problem, cancer dogs detect melanomas or even intestinal cancer, therapy dogs visit retirement homes and hospitals to lift spirits and speed recoveries.

I am fascinated with the kind of intelligence that has allowed dogs to be so successful. Whatever it is – this must be their genius.

What Is Genius?

Most of us have at some time been given a test where scores determine how we are taught or which university we attend. Alfred Binet designed the first standardized intelligence tests in the early twentieth century. His goal was to identify students in France who should receive extra scholastic attention and resources. His original test evolved into the Stanford-Binet Intelligence Scale, which is known as the IQ test.

IQ tests provide a very narrow definition of genius. As you probably remember, IQ tests focus on basic skills such as reading, writing, and analytical ability. The tests are favoured because *on average,* they predict scholastic success. But they do not measure the full capabilities of each person. They do not explain Ralph Lauren, Bill Gates, and Mark Zuckerberg, who all dropped out of university and became billionaires.

Consider Steve Jobs. One biographer said, 'Was he smart? No, not exceptionally. Instead he was a genius'. Jobs dropped out of elite Reed College in Oregon and went to find himself in India; at one point was forced out of Apple, the company he co-founded, when sales were slow in 1985. Few would have predicted the level of his success by his death. 'Think different' became the slogan of a multinational monolith that fused art and technology under his guidance. Jobs may have been average or unexceptional in many domains, but his vision and ability to think differently made him a genius.

Temple Grandin, a professor of animal studies at Colorado State University, is autistic, yet she is also the author of several books, including *Animals Make Us Human.* Grandin has also done more for animal welfare than almost anyone. Although she struggles to read people's emotions and social cues, her extraordinary understanding of animals has allowed her to reduce the stress of millions of farm animals.

A cognitive approach is about celebrating different kinds of intelligence. Genius means that someone can be gifted with one type of cognition while being average or below average in another.

The cognitive revolution changed the way we think about intelligence. It began in the decade that all social revolutions seemed to

have happened, the sixties. Rapid advances in computer technology allowed scientists to think differently about the brain and how it solves problems. Instead of the brain being either more or less full of intelligence, like a glass of wine, the brain is more like a computer, where different parts work together. USB ports, keyboards, and modems bring in new information from the environment; a processor helps digest and alter the information into a usable format, while a hard drive stores important information for later use. Neuroscientists realized that, like a computer, many parts of the brain are specialized for solving different types of problems.

Neuroscience and computer technology highlighted the fatal flaws in the idea of a single-dimensional measure of intelligence. People with well-tuned perceptual systems might be gifted athletes or artists; people with less sensitive emotional systems will succeed as fighter pilots or in other high-risk jobs; and those with unusual memories might do well as doctors. This same phenomenon can be observed in mental disorders. There are myriad cognitive abilities that are not necessarily interdependent on one another.

One of the best-studied cognitive abilities is memory. In fact, we usually think of geniuses as people who have an extraordinary memory for facts and figures, since such people often score off the charts in IQ tests. But just as there are different types of intelligence, there are different types of memory. There is memory for events, faces, navigation, things that occurred recently or long ago – the list goes on. If you have a good memory in one of these areas, it does not necessarily mean your other types of memory are equally as good.

For instance, a woman known as AJ (to protect her identity) had a remarkable autobiographical memory. She could remember when and where almost everything happened in her life. When

experimenters named various dates, she could report with uncanny precision important personal and public events that occurred – even down to the time of day. But her memory applied only to autobiographical events. She was not a particularly good student and struggled with rote memorization.

In another study, neuroscientists found that London taxi drivers had a higher density of neurons in an area of the brain called the hippocampus. The hippocampus is involved in navigation, and a higher density of neurons means more storage capacity and faster processing. This gives taxi drivers unusual abilities in solving new spatial problems requiring navigation between landmarks.

What makes AJ and taxi drivers worthy of being credited as geniuses is not what standard IQ tests measure. Rather it is their specialized, extraordinary memories.

There are many definitions of intelligence competing for attention in popular culture. But the definition that has guided my research and that applies throughout this book is a very simple one. The genius of dogs – of all animals, for that matter, including humans – has two criteria:

1. A mental skill that is strong *compared with others,* either within your own species or in closely related species.
2. The ability to make *inferences* spontaneously.

Animal Genius – Not All Just Song and Dance

Arctic terns have a genius for navigation. Each year they fly from the Arctic to the Antarctic and back. Every five years a tern will travel

the same distance it takes to get to the moon. Whales have an ingenious way of co-operating to catch fish. They create massive walls of bubbles that trap schools of fish, netting them a much heartier dinner than if they hunted alone. Honeybees have evolved a form of dance that allows them to tell other bees where to find nectar-filled flowers – it is certainly a form of genius to be able to make your living by dancing.

Genius is always relative. Certain people are considered geniuses because they are better than others at solving a specific type of problem. In animals, researchers are usually more interested in what a species as a whole is capable of, rather than each individual animal.

Even though animals cannot talk, we can pinpoint their particular genius by giving them puzzles. Animals do not need to talk to solve these puzzles, they just need to make choices. And these choices reveal their cognitive abilities. By presenting the same puzzle to different species, we can identify different types of animal genius.

Since any bird would look like a genius at navigation compared with an earthworm, it helps to compare closely related species. That way, if one species has a special ability that a close relative does not, we can not only identify their genius but also, more interestingly, ask why and how that genius exists.

For example, the spatial memory of Clark's nutcrackers easily rivals the best taxi driver. These birds live at high altitudes in the western US. In the summer, each bird may hide up to 100,000 seeds throughout its territory. In winter, Clark's nutcrackers retrieve the exact same seeds they hid nine months before, even though the seeds are covered in snow.

When compared with their corvid relatives, Clark's nutcrackers are the champions of finding food they have hidden. A tough winter

environment has made these birds into geniuses of spatial memory. However, Clark's nutcrackers do not outperform their relatives in every memory game.

Western scrub jays are also part of the corvid family, and they also frequently hide food. Unlike the solitary nutcrackers who rarely steal, however, scrub jays make a habit of it. They watch other birds hide food and later return to steal it. When tested for their ability to remember where other birds had hidden food, scrub jays proved themselves masters while nutcrackers were hopeless in the same situation. Competition has made scrub jays into geniuses of social memory. (Scrub jays do not just pilfer, they also defend against prying eyes. They prefer to hide their food in private, will re-cache their food later in a new location if another bird observes them hiding their food, and even prefer to hide food in darker locations to avoid others seeing them cache it.)

By giving different types of memory puzzles to these closely related species, scientists have been able to discern each species's unique form of genius. By observing the problems each species encounters in the wild, scientists have also been able to understand why the two show different types of genius.

As with people, just because a species looks like a genius in one area does not mean its members are geniuses in other areas. For instance, some ant species are impressive in how they co-operate. Army ants can form living bridges over water, allowing others to cross over on their backs. Other ant species fight wars to protect workers and breeders, and some even 'enslave' other ants, or keep other insects as 'pets'.

But ants have one severe limitation. They are not always very flexible. Most ants are programmed to follow the scent trails of the ants ahead of them. In the tropics, you can find an 'ant mill' where

hundreds of thousands of ants walk in a perfect circle that resembles a crawling black hole. Ant mills have been observed up to 350 metres in diameter, with a single lap taking up to two and a half hours to complete. These ant mills are also known as ant death spirals, because often the ants mindlessly follow one another in tightening circles until they exhaust themselves and die. They loyally follow the pheromones of the ants ahead of them to their death.

This leads in to the second definition of genius – the ability to make inferences. Sherlock Holmes was a genius (albeit a fictional one) because even if the solution to a mystery was not clearly apparent, he was always able to find it by making a series of inferences.

Humans make inferences constantly. Imagine speeding towards a crossroads. Even without seeing the traffic light, you can infer the light is red when you see cars entering the road from the other street.

Nature is far less predictable than traffic. Animals have to deal with unexpected surprises. For ants, following the scent of a pheromone trail is usually a foolproof method. But when the pheromone trail becomes circular, ants do not have the mental abilities to realize the trail they are following is going nowhere.

When an animal encounters a problem in the wild, they do not always have time to slowly figure out a solution through trial and error. One mistake can mean death. Hence animals need to make inferences – fast. Even when animals cannot *see* the correct solution, they can *imagine* different solutions and choose among them. This leads to a lot of flexibility. They might solve a new version of a problem they have seen before, or they might even spontaneously solve new problems they have never encountered.

Yoyo is a chimpanzee living at Ngamba Island Chimpanzee Sanctuary in Uganda. She once watched as an experimenter put a

peanut through the opening of a long transparent tube. The peanut bounced when it hit the bottom. Yoyo's fingers were too short to reach the peanut, there were no sticks around to use as a tool to reach it, and the tube was fixed and could not be turned upside down. Undaunted, Yoyo made an inference. She collected water in her mouth from the drinking fountain and spit it into the tube. The peanut floated to the top, and she happily gobbled it up. Yoyo realized she could make the peanut float, even though no water was visible when she thought of her solution. In the wild, her ability to make an inference like this could mean the difference between a good meal and starvation.

John Pilley, a retired psychology professor, adopted a Border collie named Chaser. Chaser was eight weeks old and typical of Border collies – she loved to chase and herd, she had intense visual concentration, she enjoyed being petted and praised, and she had limitless energy. Pilley had read of Rico the Border collie who knew at least two hundred German words, previously studied by Juliane Kaminski, and he was interested in seeing if there was a limit to the number of names a dog could learn. Or perhaps the memory of some of the older objects would fade as Chaser learned the names of new objects.

Chaser learned the names of one or two toys a day. Pilley, known as 'Pop', would hold up the toy and say, 'Chaser, this is . . . Pop hide. Chaser find . . .' Pilley did not use food to motivate Chaser. Instead, he used praise, hugs, and play as rewards for finding the right toy.

Over three years, Chaser learned the names of more than 800 plush toys, 116 balls, 26 Frisbees, and more than 100 plastic objects. There were no duplicates, and all of the objects differed in size, weight, texture, design, and material. In total, Chaser learned the names of more than 1,000 objects. She was tested every day, and just to be sure she was not 'cheating' by getting hints from anyone, every

month she had to complete a blind test in which she fetched objects in a different room, out of sight of Pilley and her trainers.

Even after Chaser had learnt more than 1,000 words, there was no decrease in the rate at which she learned new ones. More impressive still, the objects were organized in a variety of categories in her mind. Although the objects came in different shapes and sizes, Chaser, without any training, could distinguish between objects that were her toys and those that were non-toys.

We will discuss these studies in greater detail in Chapter 6, but for now, suffice it to say that Rico and Chaser seemed to be learning words in a way similar to human infants – they were inferring that a new word belongs to a new toy. Rico and Chaser knew the new word could not refer to their familiar toys, since they already had names. This left a toy without a name as the only possible answer.

This process of making inferences is critical in understanding how dogs think. In an experimental game, dogs were shown two cups. One of them hid a toy, and the dogs were given one chance to find it. When the experimenter showed the cup where the toy was not hidden, some dogs spontaneously inferred the toy must be in the other cup. In the right situation, many dogs can make this kind of inference.

First, we look for genius in animals by comparing one species to another. Often, the challenges different species face in the wild have provided them with different kinds of genius. Some dance, some navigate, and some have figured out how to have diplomatic relations with other species. Second, we look for genius in animals by testing their flexibility to solve new problems by making inferences.

Genius in Dogs – The Breakthrough

Until recently, science had not taken the genius of dogs very seriously. The abilities of dogs like Chaser and Rico to learn new words could have been discovered as early as 1928. In that year, C.J. Warden and L.H. Warner reported on a German shepherd named Fellow. Fellow was something of a cinematic star; his most memorable scene was saving a child from drowning in the film *Chief of the Pack*.

Much like Rico's owner, who got in contact with my colleague Juliane Kaminski, Fellow's owner contacted the scientists and reported that Fellow had learned almost four hundred words, noting that Fellow 'understands these words in much the same manner as a child under the same circumstances would'. He had raised Fellow almost from birth and talked to Fellow the way you would to a child.

Warden and Warner went to examine the dog. They had his owner give commands to Fellow from the lavatory, so he would not unwittingly give Fellow any extra unconscious cues. They found that Fellow knew at least sixty-eight commands (some of them helpful to a canine film star), such as 'speak', 'stand close to the lady', 'take a walk around the room'. Others were more impressive, such as 'go into the other room and get my gloves'.

The scientists concluded that although Fellow had nowhere near the abilities of a child, more research was needed to understand this type of intelligence in dogs. Unfortunately, their call was not answered until Juliane Kaminski undertook her research on Rico in 2004.

In the intervening seventy-five years, dogs were largely ignored.

When scientists began studying animal cognition in the 1970s, they were more interested in our primate relatives. Eventually, enthusiasm extended to other animals, from dolphins to crows. Dogs were mostly left out of the equation because they were domesticated. Domesticated animals were seen as artificial products of human breeding. Domestication supposedly dulled an animal's intelligence because they had lost the skills and intelligence needed to survive in the wild. Only two research projects were conducted to evaluate dog intelligence between 1950 and 1995, and both found dogs to be unremarkable.

Then in 1995, I did an experiment with my dog in my parents' garage and started something new. I discovered that instead of domestication making our best friends stupid, our relationship with dogs gave them an extraordinary kind of intelligence. Almost simultaneously on the other side of the world, Ádám Miklósi conducted a similar study and independently came to the same conclusion.

These studies caused an explosion in the field of dog cognition. Suddenly, people from a range of disciplines realized what had been under our noses the whole time – dogs are one of the most important species we can study, not because they have become soft and complacent compared with their wild cousins, but because they were clever enough to come in from the cold and become part of the family.

Perhaps the biggest biological mystery of all is the origin of our unlikely relationship with dogs. Every human culture on every continent for thousands of years has included dogs, from dingoes in Australia to basenjis in Africa. Our new understanding of dog genius has provided answers for some big questions about our best friends. How, when, and why did this powerful relationship begin?

And what does it mean when we think about the origins of our own species? And just as importantly, what does it mean for your relationship with your dog?

For the first time, we can hope to answer these questions. To begin our journey, and to understand how this relationship came to exist at all, we must travel back millions of years to a time long before dogs existed. Before wolves and humans had even met.