Also by Temple Grandin

Emergence: Labeled Autistic (with Margaret M. Scariano)

Thinking in Pictures: And Other Reports from My Life with Autism

Genetics and the Behavior of Domestic Animals

Livestock Handling and Transport

Also by Catherine Johnson

Shadow Syndromes: The Mild Forms of Major Mental Disorders That Sabotage Us (with John J. Ratey)

Lucky in Love: The Secrets of Happy Couples and How Their Marriages Thrive

When to Say Goodbye to Your Therapist

ANIMALS IN TRANSLATION

Using the Mysteries of Autism to Decode Animal Behavior

Temple Grandin
and Catherine Johnson

A Harvest Book • Harcourt, Inc.
Orlando Austin New York
San Diego Toronto London

1 MY STORY

People who aren't autistic always ask me about the moment I realized I could understand the way animals think. They think I must have had an epiphany.

But it wasn't like that. It took me a long time to figure out that I see things about animals other people don't. And it wasn't until I was in my forties that I finally realized I had one big advantage over the feedlot owners who were hiring me to manage their animals: being autistic. Autism made school and social life hard, but it made animals easy.

I had no idea I had a special connection to animals when I was little. I liked animals, but I had enough problems just trying to figure out things like why a really small dog isn't a cat. That was a big crisis in my life. All the dogs I knew were pretty big, and I used to sort them by size. Then the neighbors bought a dachshund, and I was totally confused. I kept saying, "How can it be a dog?" I studied and studied that dachshund, trying to figure it out. Finally I realized that the dachshund had the same kind of nose my golden retriever did, and I got it. Dogs have dog noses.

That was pretty much the extent of my expertise when I was five.

I started to fall in love with animals in high school when my mother sent me to a special boarding school for gifted children with emotional problems. Back then they called everything "emotional problems." Mother had to find a place for me because I got kicked out of high school for fighting. I got in fights because kids teased me. They'd call me names, like "Retard," or "Tape recorder."

They called me Tape Recorder because I'd stored up a lot of phrases in my memory and I used them over and over again in every conversation. Plus there were only a few conversations I liked to

have, so that amplified the effect. I especially liked to talk about the rotor ride at the carnival. I would go up to somebody and say, "I went to Nantasket Park and I went on the rotor and I really liked the way it pushed me up against the wall." Then I would say stuff like, "How did you like it?" and they'd say how they liked it, and then I'd tell the story all over again, start to finish. It was like a loop inside my head, it just ran over and over again. So the kids called me Tape Recorder.

Teasing hurts. The kids would tease me, so I'd get mad and smack 'em. That simple. They always started it, they liked to see me react.

My new school solved that problem. The school had a stable and horses for the kids to ride, and the teachers took away horseback riding privileges if I smacked somebody. After I lost privileges enough times I learned just to cry when somebody did something bad to me. I'd cry, and that would take away the aggression. I still cry when people are mean to me.

Nothing ever happened to the kids who were teasing.

The funny thing about the school was, the horses had emotional problems, too. They had emotional problems because in order to save money the headmaster was buying cheap horses. They'd been marked down because they had gigantic behavior problems. They were pretty, their legs were fine, but emotionally they were a mess. The school had nine horses altogether, and two of them couldn't be ridden at all. Half the horses in that barn had serious psychological problems. But I didn't understand that as a fourteen-year-old.

So there we all were up at boarding school, a bunch of emotionally disturbed teenagers living with a bunch of emotionally disturbed animals. There was one horse, Lady, who was a good horse when you rode her in the ring, but on the trail she would go berserk. She would rear, and constantly jump around and prance; you had to hold her back with the bridle or she'd bolt to the barn.

Then there was Beauty. You could ride Beauty, but he had very nasty habits like kicking and biting while you were in the saddle. He would swing his foot up and kick you in the leg or foot, or turn his head around and bite your knee. You had to watch out. Whenever you tried to mount Beauty he kicked *and* bit—you had both ends coming at you at the same time.

But that was nothing compared to Goldie, who reared and plunged whenever anyone tried to sit on her back. There was no way to ride that horse; it was all you could do just to stay in the saddle. If you did ride her, Goldie would work herself up into an absolute sweat. In five minutes she'd be drenched, dripping wet. It was flop sweat. Pure fear. She was terrified of being ridden.

Goldie was a beautiful horse, though; light brown with a golden mane and tail. She was built like an Arab horse, slender and fine, and had perfect ground manners. You could walk her on a lead, you could groom her, you could do anything you liked and she was perfectly behaved just so long as you didn't try to ride her. That sounds like an obvious problem for any nervous horse to have, but it can go the other way, too. I've known horses where people say, "Yeah you can ride them, but that's all you can do with them." That kind of horse is fine with people in the saddle, and nasty to people on the ground.

All the horses at the school had been abused. The lady they bought Goldie from had used a nasty, sharp bit and jerked on it as hard as she could, so Goldie's tongue was all twisted and deformed. Beauty had been kept locked in a dairy stanchion all day long. I don't know why. These were badly abused animals; they were very, very messed up.

But I had no understanding of this as a girl. I was never mean to the horses at the school (other kids were sometimes), but I wasn't any horse-whispering autistic savant, either. I just loved the horses.

I was so wrapped up in them that I spent every spare moment working the barns. I was dedicated to keeping the barn clean, making sure the horses were groomed. One of the high points of my high school career was the day my mom bought me a really nice English bridle and saddle. That was a huge event in my life, because it was mine, but also because the saddles at school were so crummy. We rode on old McClellands, which were honest-to-god cavalry saddles first used in the Civil War. The school's saddles probably went back to World War II when they still had some horse units in the army. The McClelland was designed with a slot down the center of it to spare the horse's back. The slot was good for the horse but horrible for the rider. I don't think there's ever been

a more uncomfortable saddle on earth, though I have to say that when I read about the Northern Alliance soldiers in Afghanistan riding on saddles made out of wood, that sounded worse.

Boy did I take care of that saddle. I loved it so much I didn't even leave it in the tack room where it belonged. I brought it up to my dorm room every day and kept it with me. I bought special saddle soap and leather conditioner from the saddle shop, and I spent hours washing and polishing it.

As happy as I was with the horses at school, my high school years were hard. When I reached adolescence I was hit by a tidal wave of anxiety that never stopped. It was the same level of anxiety I felt later on when I was defending my dissertation in front of my thesis committee, only I felt that way all day long and all night, too. Nothing bad happened to make me so anxious all of a sudden; I think it was just one of my autism genes kicking into high gear. Autism has a lot in common with obsessive-compulsive disorder, which is listed as an anxiety disorder in the *Diagnostic and Statistical Manual.*

Animals saved me. One summer when I was visiting my aunt, who had a dude ranch in Arizona, I saw a herd of cattle being put through the *squeeze chute* at a neighboring ranch. A squeeze chute is an apparatus vets use to hold cattle still for their shots by squeezing them so tight they can't move. The squeeze chute looks like a big V made out of metal bars hinged together at the bottom. When a cow walks into the chute an air compressor closes up the V, which squeezes the cow's body in place. The rancher has plenty of space for his hands and the hypodermic needle between the metal bars. You can find pictures of them on the Web if you want to see what they look like.

As soon as I caught sight of that thing I made my aunt stop the car so I could get out and watch. I was riveted by the sight of those big animals inside that squeezing machine. You might think cattle would get really scared when all of a sudden this big metal structure clamps together on their bodies, but it's exactly the opposite. They get really calm. When you think about it, it makes sense, because deep pressure is a calming sensation for just about everyone. That's one of the reasons a massage feels so good—it's the deep pressure. The squeeze chute probably gives cattle a feeling like the soothing

sensation newborns have when they're swaddled, or scuba divers have underwater. They like it.

Watching those cattle calm down, I knew I needed a squeeze chute of my own. When I got back to school that fall, my high school teacher helped me build my own squeeze chute, the size of a human being down on all fours. I bought my own air compressor, and I used plywood boards for the V. It worked beautifully. Whenever I put myself inside my squeeze machine, I felt calmer. I still use it today.

I got through my teenage years thanks to my squeeze machine and my horses. Animals kept me going. I spent every waking minute that I didn't have to be studying or going to school with those horses. I even rode Lady at a show. It's hard to imagine today, a school keeping a stable of emotionally disturbed and dangerous horses for its underaged students to ride. These days you can't even play dodgeball in gym class because somebody might get hurt. But that's the way it was. A lot of us got nipped or stepped on or thrown at that school, but no one was ever seriously hurt, at least not while I was there. So it worked out.

I wish more kids could ride horses today. People and animals are supposed to be together. We spent quite a long time evolving together, and we used to be partners. Now people are cut off from animals unless they have a dog or a cat.

Horses are especially good for teenagers. I have a psychiatrist friend in Massachusetts who has a lot of teenage patients, and he has a whole different set of expectations for the ones who ride horses. He says that if you take two kids who have the same problem to the same degree of severity, and one of them rides a horse regularly and the other one doesn't, the rider will end up doing better than the nonrider. For one thing, a horse is a huge responsibility, so any teenage kid who's looking after a horse is developing good character. But for another, riding a horse isn't what it looks like: it isn't a person sitting in a saddle telling the horse what to do by yanking on the reins. Real riding is a lot like ballroom dancing or maybe figure skating in pairs. It's a relationship.

I remember looking down to make sure my horse was on the right lead. When a horse is cantering around the ring one of his front hooves has to thrust out farther forward than the other one,

and the rider has to help him do that. If I leaned my body just the right way, it helped my horse get on the right lead. My sense of balance was so bad I could never learn to parallel ski no matter how hard I tried, though I did reach the advanced snowplow stage. Yet there I was, moving my body in sync with the horse's body to help him run right.

Horseback riding was joyous for me. I can remember being on a horse sometimes and we'd gallop in the pasture and that was such a big thrill. Of course it's not good for horses to run them all the time, but once in a while we'd get to have a little run, and I'd feel exhilarated. Or we'd be out on a trail riding, and do a really fast gallop down the road. I remember what it looked like, the trees whizzing by; I remember that really well to this day.

Riding becomes instinctual after a while; a good rider and his horse are a team. It's not a one-way relationship, either; it's not just the human relating to the horse and telling him what to do. Horses are super-sensitive to their riders and are constantly responding to the riders' needs even without being asked. School horses—the horses a stable uses to teach people how to ride—will actually stop trotting when they feel their rider start to lose his balance. That's why learning to ride a horse is completely different from learning to ride a bicycle. The horses make sure nobody gets hurt.

The love a teenager gets from a horse is good for him, and so is the teamwork. For years people always said you needed to send difficult kids to military school or the army. A lot of times that works because those places are so highly structured. But it would work a lot better if military schools still had horses.

—

Animals in Translation comes out of the forty years I've spent with animals.

It's different from any other book I've read about animals, mostly because I'm different from every other professional who works with animals. Autistic people can think the way animals think. Of course, we also think the way people think—we aren't *that* different from normal humans. Autism is a kind of way station on the road from animals to humans, which puts autistic people like me in a perfect

position to translate "animal talk" into English. I can tell people why their animals are doing the things they do.

I think that's why I was able to become successful in spite of being autistic. Animal behavior was the right field for me, because what I was missing in social understanding I could make up for in understanding animals. Today I've published over three hundred scientific papers, my Web site gets five thousand visitors each month, and I give thirty-five lectures on animal management a year. I give another twenty-five or so on autism, so I'm on the road most of the time. Half the cattle in the United States and Canada are handled in humane slaughter systems I've designed.

I owe a lot of this to the fact that my brain works differently.

Autism has given me another perspective on animals most professionals don't have, although a lot of regular people do, which is that animals are smarter than we think. There are plenty of pet owners and animal lovers out there who'll tell you "little Fluffy can think," but animal researchers have mostly dismissed this kind of thing as wishful thinking.

But I've come to realize that the little old ladies are right. People who love animals, and who spend a lot of time with animals, often start to feel intuitively that there's more to animals than meets the eye. They just don't know what it is, or how to describe it.

I stumbled across the answer, or what I think is part of the answer, almost by accident. Because of my own problems, I've always followed neuroscientific research on the human brain as closely as I've followed my own field. I had to; I'm always looking for answers about how to manage my own life, not just animals' lives. Following both fields at the same time led me to see a connection between human intelligence and animal intelligence the animal sciences have missed.

The literature on autistic savants sparked my discovery. Autistic savants are people who can do things like tell you what day of the week you were born based on your birth date, or calculate in their heads whether your street address is a prime number or not. They usually have IQs in the mentally retarded range, though not always, yet they can *naturally* do things no normal human being can even be *taught* to do, no matter how hard he tries to learn or how much time he spends practicing.

Animals are like autistic savants. In fact, I'd go so far as to say that animals might actually *be* autistic savants. Animals have special talents normal people don't, the same way autistic people have special talents normal people don't; and at least some animals have special forms of genius normal people don't, the same way some autistic savants have special forms of genius. I think most of the time animal genius probably happens for the same reason autistic genius does: a difference in the brain autistic people share with animals.

The reason we've managed to live with animals all these years without noticing many of their special talents is simple: we can't see those talents. Normal people never have the special talents animals have, so normal people don't know what to look for. Normal people can stare straight at an animal doing something brilliant and have no idea what they're seeing. Animal genius is invisible to the naked eye.

I'm sure I don't know all the talents animals have, either, let alone all the things they could use their talents to do if we gave them the chance. But now that I've seen the connection between autistic savantry and animal genius at least I have an idea what I'm looking for: I'm looking for ways animals can use their amazing ability to *perceive things humans can't perceive,* and to *remember highly detailed information we can't remember,* to make life better for everyone, animals and people alike. Just off the top of my head, here's a thought: we have service dogs for the blind—how about service dogs for the middle-aged whose memories are going? I'm willing to bet that just about any dog can remember where you put your car keys better than you can if you're over forty, and probably if you're under forty, too.

Or how about service dogs who remember where your kids left the remote control? I bet a dog could do this if you gave him the training.

Of course, I don't know this for a fact. I could be wrong. But for me, predicting animal talents is getting to be a little like astronomers predicting the existence of a planet nobody can see based on their understanding of gravity. I'm starting to be able to accurately predict animal talents nobody can see based on what I know about autistic talent.

—

Seeing the Way Animals See: The Visual Environment

The only research I was interested in doing at Arizona State was studying visual illusions in animals. I'm sure I was interested in visual illusions because I'm a visual thinker. I didn't know it at the time, but being a visual thinker was the start of my career with animals. It

gave me an important perspective other students and professors didn't have, because animals are visual creatures, too. Animals are controlled by what they see.

When I say I'm a visual thinker I don't mean just that I'm good at making architectural drawings and designs, or that I can design my cattle-restraining systems in my head. I actually think in pictures. During my *thinking* process I have no words in my head at all, just pictures.

That's true no matter what subject I'm thinking about. For instance, if you say the word "macroeconomics" to me I get a picture of those macramé flowerpot holders people used to hang from their ceilings. That's why I can't understand economics or algebra; I can't picture it accurately in my mind. I flunked algebra. But other times thinking in pictures is an advantage. During the 1990s I knew all the dot-coms would go to hell, because when I thought about them the only images I saw were rented office space and computers that would be obsolete in two years. There wasn't anything real I could picture; the companies had no hard assets. My stockbroker asked me how I knew the two stock market crashes would happen, and I told him, "When the Monopoly play money starts jerking around the real money you're in trouble."

If I'm thinking about a structure I'm working on, all of my judgments and decisions about it happen in pictures. I see images of my design going together smoothly, images of problems and sticking points, or images of the whole thing collapsing if there's a major design flaw.

That's the point where words come in, *after* I've finished thinking it through. Then I'll say something like, "That won't work because it will collapse." My final judgment comes out in words, but not the process that led up to the judgment. If you think about a judge and jury, all my deliberations are in pictures, and only my final verdict is in words.

If I'm alone I'll say the verdict out loud, though I don't do it with other people around because I know I'm not supposed to. In college I did a lot of talking out loud because it helped me organize my thinking. A lot of autistic people talk out loud for the same reason. I'll also do some extremely simple running commentary in

words. I'll say, "Let's try this," or, "Oh boy! I figured it out." The language is always simple. It's the pictures that are complex.

When I talk to other people I translate my pictures into stock phrases or sentences I have "on tape" inside my head. Those kids who called me Tape Recorder were right about me. They were mean, but they were right. I *am* a tape recorder. That's how I'm able to talk. The reason I don't sound like a tape recorder anymore is that I have so many stock phrases and sentences I can move around into new combinations. All my public speaking has been a huge help. When I got criticisms saying I always gave the same speech, I started moving my slides around. That moved my phrases around, too.

When I was young I had no idea that being a visual thinker made me different from anyone else. I thought everyone saw pictures inside their heads. So naturally, when I didn't like the lab work I was doing and wanted to start learning about animals in their natural environments, I focused on the visual environment. It wasn't a conscious decision, it was just what I naturally gravitated to.

Being verbal thinkers, behaviorists hadn't really thought about the visual environment. When they talked about the environment rewarding or punishing an animal in response to something it did, they usually meant food and electric shocks. That made sense for a Skinner box, where there's nothing much to look at, and if you mess up you get a shock. (A Skinner box was a special cage, usually a Plexiglas box, behaviorists used to test and analyze a rat's behavior. There was nothing in it except a lever and maybe some indicator lights that went on or off when a reward was available.) Most Skinner boxes didn't shock the animals, but if punishment was part of the experiment, usually the punishment would be a shock.

In the wild, though, there aren't any electric shocks, and you can't get food by pecking a lever. *You get food by being highly attuned to the visual environment.* Behaviorists finally started to catch on to the importance of vision to an animal when somebody did a famous experiment showing you could teach a monkey how to push a lever just by letting him look outside a window every time he hit the lever. They didn't need to give the monkey a food reward, just a view. Animals *need* to see, and they *want* to see.

While I was doing my research on visual illusions in the lab I started to hang out in feed yards with the cattle, where I noticed that a lot of times the animals didn't want to go through the chutes, which are the narrow passageways the cattle go through on the way to the squeeze chute. When I saw cattle balking and acting scared I just naturally thought, "Well let's look at it from the animal's point of view. I've got to get in the chute and see what he's seeing."

So I took pictures inside the chutes from the cattle's point of view. I even put black-and-white film in my camera because we thought animals saw in black and white. (Later on we learned that they see colors, too, but not in as wide a spectrum as we do.) I wanted to see what *they* were seeing.

That's when I noticed that simple things, like shadows or chains hanging down, made the animals balk.

The people at the feed yards thought my whole project was ridiculous. They couldn't imagine why I'd get in there and try to see what the cattle were seeing. Now I realize that in my own way I was being just as anthropomorphic as those people who gave the lion the pillow. Since I was a visual thinker I assumed cows were, too. The difference was I happened to be right.

When you're trying to understand how the environment is affecting an animal's behavior, you *have* to look at what the animal is seeing. I remember one time I went to a plant where they had a yellow metal ladder on a wall inside a building. The cattle had to go by it when they walked through a narrow alley. Those cattle just would not walk by that ladder. They'd plant their feet on the ground and refuse to move. Finally one of the yard people figured out the problem. He painted the ladder gray, and everything was fine. I work with management and with the employees down on the floor or in the yard, and I've found that a lot of times the guys in the yard are better at understanding animals than management.

If a cow sees a yellow raincoat flapping on a fence, she's in a panic. But if you aren't a visual thinker, it can be hard to even *notice* that yellow raincoat flapping on the fence. It doesn't jump out at normal people the way it does at me or at a cow.

Since I didn't realize other people thought in words instead of pictures, for a long time I could never figure out why so many animal

handlers made such obvious, elementary mistakes. Not all of them do; I've met lots of good animal handlers in the meatpacking industry. But I was always surprised when I found an animal professional doing something that was just plain dumb. Why couldn't they see what they were doing wrong?

I remember one situation in particular, where the owner of a cattle-handling facility hired me as a last resort before they tore the whole place down and built it back up from the ground. He called me because his cattle wouldn't walk inside the narrow passage leading to the squeeze chute.

The problem wasn't that the cattle were afraid of getting their shots. Most cattle don't even know they're going to be getting shots inside the chute. Besides, a lot of animals barely feel their shots anyway. New dog owners are always surprised by this. They'll watch their dog cower and cringe as the vet examines him, then not blink an eye when he sticks him with a needle. Some vets say that's the difference between a dog, who isn't anticipating pain, and a person, who is. Thinking about a shot makes it worse.

The problem at the cattle-handling facility had to be something they were doing wrong, since those cattle were perfectly fine before they got there. But the owner couldn't figure it out. He needed to fix the situation fast, too, because skipping vaccinations isn't an option. Cattle aren't like children, who get vaccinated against a lot of diseases like polio or whooping cough that are pretty hard to catch nowadays. Cattle are extremely susceptible to bovine viral diarrhea and to respiratory diseases like pneumonia. If they don't get their shots, infectious disease will sweep through the herd and kill 10 percent of the animals. So you have to vaccinate, and in order to vaccinate you have to have your cattle walk into the squeeze chute. These cattle wouldn't do it, and the owner was starting to panic.

Things had gotten so bad the handlers were using cattle prods, which are fiberglass rods with two prongs on the end that deliver an electric shock to an animal. Prods will get an animal moving, but they're stupid things to use because they can panic the animals and make them rear up, which is dangerous for the workers. Prods always stress an animal, and when an animal is stressed his immune system goes down and he starts getting sick, which means higher

veterinary bills. Plus stressed animals gain less weight, which means less meat to sell. Dairy cattle who've been handled with prods give less milk.

Stress is bad for human growth, too, although most people don't realize it. The one thing people do know about is *failure to thrive*, when children who've been badly abused or neglected suffer *stress dwarfism*. The child's biology is normal and he's eating enough food, but he doesn't grow. Stress dwarfism is pretty rare, but there's evidence that stressed children, just like stressed animals, can grow more slowly than calmer children. Researchers have known for quite a while that anxious adults often have low levels of growth hormone, and a study in 1997 found that anxious girls, though not anxious boys, were more likely to be short than calm girls.

My guess is that eventually we'll find out anxious boys are smaller, too. Anxious male animals are smaller than calm male animals, and I don't see any reason why human males should be different. I think the German orphanage story probably tells us stress is bad for boys, too. That's the famous case of two orphanages in postwar Germany where one was run by a nice headmistress, while a mean lady who made fun of the children in front of their friends ran the other. She was nice only to the eight children who were her special favorites.

None of the children had enough food, and all of them were smaller than they were supposed to be. Then a natural experiment happened when the government gave the children living with the nice lady extra rations—at the very same moment that the nice lady quit her job and left, and *the mean lady was hired in her place*. The eight teacher's pets moved to the new orphanage with the mean director. Doctors were measuring all the children's growth, and they found that even though the children in the first orphanage were getting extra food, now that they were stressed by a nasty adult they didn't grow as well as the children in the other orphanage. They had more food but grew less. The eight favorites grew better than anyone. Both orphanages had boys as well as girls, so I assume the boys' growth was slowed by stress, too.

With animals there's no ambiguity: stress is horrible for growth, period, which means stress is horrible for profits. So even a feedlot owner who doesn't care about an animal's feelings doesn't like using prods, because a stressed animal means financial loss.

When I got to the feedlot it took me about ten minutes to figure out the problem.

To get to the squeeze chute, first the animals had to walk inside the barn door into a round holding area called a crowd pen. That part of the procedure went off without a hitch. The cattle didn't have any problem stepping inside the pen.

Next they were supposed to walk into a curved single-file alley (it's also called a chute) that led to the squeeze chute. That was where the cattle balked. They just would not walk into the alley. It was the exact same alley feedlots all over the world were using without any trouble, so no one could figure out what the problem was. They couldn't see anything about their setup that was different from any other setup.

But to me it was obvious: the alley was too dark. The cattle were supposed to walk from broad daylight into an unlit indoor alley, and the contrast in illumination was too sharp. They were afraid to walk into pitch-black space.

That might seem a little surprising, since prey animals, like cattle, deer, and horses, usually like the dark. They can hide in the dark and feel safe, or at least safer than they feel during the day. But the problem wasn't the dark, it was the contrast of going from bright sunlight to a dark interior. Animals never like going from bright to dark. They don't like any kind of experience that temporarily blinds them, and that includes looking into a bright light when they're standing in relative darkness. I've found that cattle won't even walk toward a glaring lightbulb. You have to use indirect lighting at the mouth of an alley to make it work.

As soon as I saw the setup I figured that was the problem, and I confirmed my guess when I asked the owner how the cattle behaved at different times of the day, and in different kinds of weather. When he thought about it, he realized that the facility worked fine at night. Things weren't too bad on cloudy days, either. It was the bright, sunny days that were impossible, but no one had noticed the pattern.

I think a number of things are at work when an animal reacts that way. Cattle have excellent night vision and are used to seeing well in the dark, unlike people. So the experience of going temporarily

blind in the seconds before their irises expand, which is something people take for granted, probably makes them panic. Also, cows don't live in houses with electricity and drive around in cars at night the way we do, so they don't develop a mental category called "eyes adjusting to an abrupt change in illumination." Last but not least, animals are so intensely sensitive to the visual world that I wouldn't be surprised to find out that sudden huge changes in illumination are physically painful in some way. People don't enjoy the experience of moving from brilliant light to a dark room, either, but for a cow it must be overwhelming.

Maybe when those cattle started to walk out of the sun into the chute they felt like they were going blind for real. They might have been having the same reaction you or I would have if we were driving down the street and suddenly went blind every time we drove through an underpass. If you went blind every time you drove through an underpass you wouldn't drive through underpasses.

I always tell people: whenever you're having a problem with an animal, *try to see what the animal is seeing* and experience what the animal is experiencing. There are lots of things that can upset an animal—smells, changes in routine, exposure to things he hasn't experienced before—and you should consider all of them. Anything in the sensory realm can upset an animal. But don't forget to ask yourself what your dog, cat, horse, or cow may be *seeing* that's bothering him.

At that feedlot, all they needed to do was get more light inside the barn. They could have fixed the problem themselves in five minutes if they'd been able to think about the chute from the animal's point of view. The answer was right in front of them. I really do mean directly in front of them, because the people who built the barn in the first place had installed a big sliding garage door on the front of the barn that the owner had left closed.

When I told him all they needed to do was open the door, it turned out that it hadn't been opened once since the lot was built. They didn't even know if they *could* open it after all this time. But they got a couple of guys to put their shoulders up against the door, and after a few minutes of straining and grunting they got the thing open. That was the end of the problem. The cows all walked into the chute just as nice as could be.

What People See and Don't See

That feedlot consultation was the kind of thing that started to give me a reputation for having practically a magical connection to animals. Meanwhile I was always mystified by these situations, because to me the answers seemed so obvious. Why couldn't other people *see* what the matter was?

It took me fifteen years to figure out that other people actually *couldn't* see what the problem was, at least not without a lot of training and practice. They couldn't see it because they weren't visually oriented the way animals and autistic people are.

I always find it kind of funny that normal people are always saying autistic children "live in their own little world." When you work with animals for a while you start to realize you can say the same thing about normal people. There's a great big, beautiful world out there that a lot of normal folks are just barely taking in. It's like dogs hearing a whole register of sound we can't. Autistic people and animals are *seeing* a whole register of the visual world normal people can't, or don't.

I don't just mean this metaphorically, either. Normal people literally don't see a lot of things. There's a famous experiment by a psychologist named Daniel Simons, head of the Visual Cognition Lab at the University of Illinois, called *Gorillas in Our Midst,* that shows you how bad people's visual awareness is. In the experiment they show people a videotape of a basketball game and ask them to count how many passes one team makes. Then, a little while into the tape, while everyone is sitting there counting passes, a woman wearing a gorilla suit walks onto the screen, stops, turns, faces the camera, and beats her fists on her chest.

Fifty percent of all people who watch this video *don't see the gorilla!*

Even when experimenters ask them directly, "Did you notice the gorilla?" they say, "The what?" It's not that they don't *remember* the lady in the gorilla suit. Anyone who's forgotten something he saw will remember it when you give him a prompt. These folks actually didn't see the lady gorilla in the first place. She didn't register.[6]

The experimenters tested out their theory with another video in

which an actor suddenly changes into a whole different person, wearing a completely different set of clothes. Seventy percent of normal people don't notice that, either. They also don't notice it in real life. In one study a blond-haired man wearing a yellow shirt handed students a form to fill out, then took the completed form behind a bookcase to file. When he came back out he was a dark-haired man wearing a blue shirt. He wasn't the same guy in disguise; he was a whole different person. It didn't matter. Seventy-five percent of the students had no idea they'd just interacted with two different people.

The scariest study, though, was the one NASA did with commercial airplane pilots. The researchers put them in a flight simulator and asked them to do a bunch of routine landings. But on some of the landing approaches the experimenters added the image of a large commercial airplane parked on the runway, something a pilot would never see in real life (at least, let's hope not). *One quarter of the pilots landed right on top of the airplane.* They never saw it.

I've seen photographs from the study, and what's interesting is that if you're *not* a pilot, the parked plane is obvious. You can't miss it, and you don't have to be autistic to see it, either.[7] I'd bet the ranch that the only people who could possibly miss that plane would have to be commercial pilots. If you're a professional, expecting to see what a professional normally *would* see, there's a 25 percent chance you'll miss a huge commercial aircraft parked crossways blocking the landing strip in a flight simulator.

That's because normal people's perceptual systems are built to see what they're used to seeing. If they're used to seeing gorillas in the middle of basketball games, they see gorillas. If they're not used to seeing gorillas in the middle of basketball games, they don't. They have *inattentional blindness.*

I have no idea how a visual thinker would do on these experiments, but my guess is visual thinkers would see the gorilla a lot more often than verbal thinkers. I'm almost positive there's no prey animal on earth who would miss that gorilla, that's for sure, though I think predators would see the gorilla, too. A *predator,* by the way, is an animal like a dog or a cat who hunts and kills other animals for food; a *prey animal* is the animal the predator hunts. There's also another category of animals you don't hear about as much, which is

the *scavenger* animals (like vultures) who do eat meat but don't kill the animals they eat. All animals, including human beings, fall into at least one of these categories, and quite a few—including a lot of primates—belong to more than one. Humans are more predators than prey, but we share qualities with both. In terms of the size of our teeth, we're defenseless, but as soon as we developed tools we became predators.

It's so hard for normal people to see what scares cattle that I finally developed a checklist of mostly visual details for plant managers to look out for. Things like pieces of metal that wiggle, reflections on water, bright spots, contrasts of color, and air hissing or blowing in their faces. I tell the owners, if you have three "bad" details you have to correct *all three.* Then your animal will walk up the chute without any trouble and you can throw away your electric prod.

Visual thinkers of any species, animal or human, are detail-oriented. They see everything and they react to everything. We don't know why this is true, we just know from experience that it is. I've had interior designers tell me, "I see everything." The worst thing that can happen to an interior designer is to work with a sloppy contractor. The designer will see every little flaw in the contractor's work. Tiny mistakes no one else even notices, like grout that's slightly uneven, will jump out at visual people. They go crazy. Visual people feel horrible when little details in their visual environments are wrong, the same way animals do.

I think this is probably the hardest part of an animal's existence for normal people to relate to. Verbal people can't just turn themselves into visual people because they want to, and vice versa.

—

I hope this book will help regular people be a little less verbal and a little more visual. I've spent thirty years as an animal scientist, and I've spent my whole life as an autistic person. I hope what I've learned will help people start over again with animals (and maybe with autistic people, too), and begin to think about them in a different way.

I hope what I've learned will help people *see.*

Write To:

7 ANIMAL GENIUS: EXTREME TALENTS

It's getting to be obvious even to skeptics that animals are smarter than we think.

The question is, how much smarter?

My answer is that there are some animals who, like some people, have a form of genius. These animals have talents that are so extraordinary they're way past anything any normal human being could do even with a lot of hard work and practice.

Who are these animals?

Birds, for one. The more I learn about birds, the more I'm beginning to think we have no idea what the limits to some bird species' intelligence are. Bird migration is probably the most extraordinary talent we know about right now. Birds have brains no bigger than a walnut, but they can learn and remember migratory routes thousands of miles in distance. The Arctic tern has the longest migratory route we know about: 18,000 miles, round-trip. Some of these birds travel from the North Pole to the South Pole and back again every year.

Extreme Memory

What makes this a genius-level ability instead of just some miraculous ability that's built into the species, like having wings and being able to fly, is the fact that birds have to *learn* these routes. They aren't born knowing their species' migratory route; it isn't hardwired. Moreover, they learn the routes with almost no effort at all.

Many migratory birds have genius-level learning abilities when it comes to migration.

There's a good movie about these birds called *Fly Away Home,* based on the story of Bill Lishman, the man who, along with his partner, Joseph Duff, taught a bunch of Canada geese to follow him in his ultralight airplane. They created the project because they wanted to try to save the whooping cranes, which are on the verge of extinction. Operation Migration, the charity Bill Lishman founded, says there are only 188 whooping cranes left in the world. They're all in one big flock, which makes them even more vulnerable to extinction.

Up until Bill Lishman came along people were trying to save the species by raising baby whooping cranes in captivity. But it wasn't working because when the babies were brought up without any migrating adults to teach them the routes, there was no way to reintroduce them to the wild. They didn't know how to migrate, so when winter came they would just stay put and die in the cold.

Bill Lishman had the idea of teaching the whooping cranes to migrate by leading them along a migration path in his ultralight plane, a small one-person airplane that can fly as slowly as 28 to 58 miles per hour. He started out working with Canada geese, because geese aren't in danger of going extinct. Any golfer on the East Coast can tell you there's no goose shortage. As a matter of fact the goose poop problem has gotten so out of hand that some Border collies are getting a brand-new job working goose patrol at golf courses. That's good, because Border collies need a job. They get antsy living a life of leisure.

Pretty quickly Mr. Lishman managed to show that you could teach geese to follow a human in an ultralight airplane, ***and*** you could teach them a four-hundred-mile one-way migration route flying it just once. No human being could memorize a four-hundred-mile route across unmarked open terrain after traveling it just one time. Bird migration is an extreme talent.

After he knew he could do it with geese, he switched to sandhill cranes, which are related to whooping cranes but aren't endangered. In 1997 he led seven sandhill cranes from southern Ontario down to

Virginia, a four-hundred-mile trip one way. The cranes spent the winter in Virginia and then, one day at the end of March, they went out for their daily foraging and didn't come back. Two days later Mr. Lishman got a call from a school principal up in Ontario who said he had six big birds in his schoolyard entertaining the students! Six of the seven birds had made it the whole four hundred miles back to Canada, after having flown the route only once in their lives, and in the opposite direction. They ended up thirty miles away from where they'd been fledged.

Lots of animals have extreme memory and learning abilities in one realm or another. Gray squirrels bury hundreds of nuts every winter, one nut in each burial spot, and they remember them all. They remember where they hid each nut, what kind of nut it was, and even when they hid it. They're not just marking the spots some way, or finding the nuts by smell, which is what a lot of people probably assume. I read a gardening column the other day where a woman wrote in asking whether there was any way to keep squirrels from digging up her garden. The columnist answered that squirrels forget where they've buried their nuts, so they dig everything up. That is ***not*** true. Squirrels remember exactly where they buried hundreds and hundreds of nuts. Dr. Pierre Lavenex at the University of California, Berkeley, a researcher who studies memory in gray squirrels, says, "They use information from the environment, such as the relative position of trees and buildings, and they triangulate, relying on the angles and distances between these distant landmarks and their caches."[1]

No human can do that. A normal human can't even remember where he put the car keys half the time, let alone where he buried five hundred individual nuts. How long would a person last if he had to eat buried nuts for food? He wouldn't get through the winter, that's for sure. "People can do this [i.e. triangulate landmarks to find the precise spot where they've buried something] for a few sites," Dr. Lavenex says, "maybe six or seven, but not for nearly as many as squirrels do."

Most animals have "superhuman" skills like this: ***animals have animal genius.*** Birds are navigation geniuses, dogs are smell geniuses, eagles are visual geniuses—it can be anything.

Extreme Perception and Animal Intelligence

Many animals also have extreme perception. Forensic dogs are three times as good as any X-ray machine at sniffing out contraband, drugs, or explosives, and their overall success rate on tests is 90 percent.

The fact that a dog can smell things a person can't doesn't make him a genius; it just makes him a dog. Humans can see things dogs can't, but that doesn't make us smarter.

But when you look at the jobs some dogs have invented for themselves using their advanced perceptual abilities, you're moving into the realm of true cognition, which is solving a problem under novel conditions. The seizure alert dogs are an example of an animal using advanced perceptual abilities to solve a problem no dog was born knowing how to solve. Seizure alert dogs are dogs who, their owners say, can *predict* a seizure before it starts. There's still controversy over whether you can train a dog to predict seizures, and so far people haven't had a lot of luck trying. But there are a number of dogs who have figured it out on their own. These dogs were trained as seizure-response dogs, meaning they can help a person once a seizure has begun. The dog might be trained to lie on top of the person so he doesn't hurt himself, or bring the person his medicine or the telephone. Those are all standard helpful behaviors any dog can be trained to perform.

But some of these dogs have gone from responding to seizures to perceiving signs of a seizure ahead of time. No one knows how they do this, because the signs are invisible to people. No human being can look at someone who's about to have a seizure and see (or hear, smell, or feel) what's coming. Yet one study found that 10 percent of owners said their seizure response dogs had turned into seizure alert dogs.

The *New York Times* published a terrific article about a woman named Connie Standley, in Florida, who has two huge Bouvier des Flandres dogs who predict her seizures about thirty minutes ahead of time.[2] When they sense Ms. Standley is heading into a seizure they'll do things like pull on her clothes, bark at her, or drag on her hand to get her to someplace safe so she won't get hurt when the seizure begins. Ms. Standley says they predict about 80 percent of her seizures. Ms. Standley's dogs apparently were trained as seizure alert dogs before they came to her, but there aren't many dogs in that category. Most of the seizure alert dogs were trained to respond to seizures, not predict seizures.

The seizure alert dogs remind me of Clever Hans. Hans was the world-famous German horse in the early 1900s whose owner, Wilhelm von Osten, thought he could count. Herr von Osten could ask the horse questions like, "What's seven and five?" and Hans would tap out the number 12 with his hoof. Hans could even tap out answers to questions like, "If the eighth day of the month comes on Tuesday, what is the date for the following Friday?" He could answer mathematical questions posed to him by complete strangers, too.

Eventually a psychologist named Oskar Pfungst managed to show that Hans wasn't really counting. Instead, Hans was observing subtle, unconscious cues the humans had no idea they were giving off. He'd start tapping his foot when he could see it was time to start tapping; then he'd stop tapping his foot when he saw it was time to stop tapping. His questioners were making tiny, unconscious movements only Hans could see. The movements were so tiny the humans making them couldn't even *feel* them.

Dr. Pfungst couldn't see the movements, either, and he was looking for them. He finally solved the case by putting Hans's questioners out of view and having them ask Hans questions they didn't know the answers to themselves. It turned out Hans could answer questions only when the person asking the question was in plain view and already knew the answer. If either condition was missing, his performance fell apart.

Psychologists often use the Clever Hans story to show that humans who believe animals are intelligent are deluding themselves. But that's not the obvious conclusion as far as I'm concerned. No one has ever been able to *train* a horse to do what Hans did. Hans trained himself. Is the ability to read a member of a different species as well as Hans was reading human beings really a sign that he was just a "dumb animal" who'd been classically conditioned to stamp his hoof? I think there's more to it than that.

What makes Hans similar to the seizure alert dogs is that both Hans and the dogs acquired their skills without human help. As I mentioned, to my knowledge, so far no one's figured out how to take a "raw" dog and teach it how to predict seizures. About the best a trainer can do is reward the dogs for helping when a person is having a seizure and then leave it up to the dog to start identifying signs that predict the onset of a seizure on his own. That approach hasn't been hugely successful, but some dogs do it. I think those dogs are showing superior intelligence the same way a human who can do something few other people can do shows superior intelligence.

What makes the actions of the seizure alert dogs, and probably of Hans, too, a sign of high intelligence—or high talent—is the fact that they didn't have to do what they did. It's one thing for a dog to start recognizing the signs that a seizure is coming; you might chalk that up to unique aspects of canine hearing, smell, or vision, like the fact that a dog can hear a dog whistle while a human can't. But it's another thing for a dog to start to recognize the signs of an impending seizure and *then decide to do something about it.* That's what intelligence is in humans; intelligence is people using their built-in perceptual and cognitive skills to achieve useful and sometimes remarkable goals.

Invisible to the Naked Eye

By now you're probably thinking, if animals are so smart, why hasn't anyone noticed?

First of all, we have no idea what most animals are doing in the wild. Even when people like Jane Goodall have been able to spend years doing close observation of a group of animals in their native habitat, we still don't learn what the *animals* think they're doing, or what they're communicating to one another about what they're doing. That's why it's always a surprise when a crow like Betty spontaneously bends a wire to make a food hook, or a gray parrot like Alex suddenly spells the word "nut." Just the other day I met a lady at a conference who told me about another super-smart bird living in a Florida hotel. This bird is a macaw who invented a new word—

crackey—to signify either cookie or cracker. Those are the two foods his owner gives him as treats, so apparently the macaw decided that *cookie-cracker* is a food category unto itself, requiring its own word, which he created by putting "cookie" and "cracker" together. He's right about cookies and crackers; they *are* a separate category. Cookies and crackers are both treats, not "real" food. I'm guessing that's what the bird means when he asks for a crackey; he's probably asking for junk food.

Another gray parrot, N'Kisi, owned by Aimee Morgana in New York City, has a vocabulary of over five hundred English words. She uses the present, past, and future tenses and once used the word "flied" to mean "flew." She called the aromatherapy oils Aimee uses "pretty smell medicine."

The point is, we don't know what animals can and can't do. The fact that we're constantly being dumbfounded by brand-new abilities no one had a clue animals possessed ought to be a lesson to us about how much we don't know.

If Animals Are So Smart, Why Aren't They in Charge?

I think the reason researchers don't take this lesson more to heart is that most people just naturally assume, without stopping to think about it, that if animals were as smart as humans or smarter, they'd have more to show for it. Where are all the animal inventions? That's the big question.

This is the if-animals-were-smart-they-wouldn't-still-be-pooping-in-the-woods theory of animal cognition. If animals were *really* smart, they would have invented flush toilets!

What the indoor plumbing theory of animal IQ forgets is the fact that plenty of indigenous peoples never invented indoor plumbing, either, and they're no less intelligent than anyone else. Our thinking about animals is a lot like the Europeans' thinking about primitive cultures in the nineteenth century when European explorers first began to have a lot of contact with the people of Africa. That was a time when botanists and zoologists were creating classifications for every plant and animal on earth, so naturally Europeans created

classifications for humans, too. They thought the Europeans were the most intelligent, the Asians were next most intelligent, and the Africans were on the bottom.

The Europeans were wrong about that, probably for some of the same reasons people will turn out to be wrong about animals, too. One big mistake the Europeans made was to equate *IQ* with *cultural evolution. Cumulative cultural evolution* means that each generation can build on the knowledge of the generation before it rather than having to start all over again from scratch. For a culture to evolve, you have to have *cultural ratcheting,* which means that a group of people or animals has to have a way to hold on to the things the previous generations have learned so the next generation can add on new things.[3] Cultural ratcheting means a culture can maintain and pass along an expanding body of knowledge that no one generation would be able to invent for itself.

Researchers don't know how and why one culture evolves faster than another, but they do know it's not because of IQ. You probably have to have things like direct, one-on-one teaching along with *very* widespread paying attention and learning so you don't keep losing knowledge as fast as you gain it.

All human cultures, including indigenous peoples, have *cumulative cultural evolution* to some degree. But so far researchers think only birds and *maybe* chimpanzees also have it. However, there is so much of animal life we just can't perceive at this point, that the time hasn't come to conclude that animals do or do not have cultural evolution. Take dolphins, for instance. Dolphins talk back and forth to each other for hours on end. It's completely possible dolphins could have a rich "mental" culture they've developed over many generations that's invisible to us. How would we know one way or the other?

I thought about dolphins when I read *A Man Without Words.* In deaf culture people sign the same information to each other over and over again to make sure every person understands it and has the same information. The author, Susan Schaller, talks about a picnic she attended where "even though everyone saw my name and where I was from in my [signed] introduction, the spelling of my English name, my namesign, and California's namesign passed from person

to person until everyone was completely satisfied that they had all seen the exact same information."

I wonder whether dolphins are doing something like that, passing precious cultural information from dolphin to dolphin over and over again to make sure none of it gets lost. Dolphins don't have books or hands, so they can't record the things they know in writing *or* in objects they've built. I say this because early humans didn't have written language, either, but they made simple tools, clothing, and shelters that could probably serve both as objects *and* as the instructions on how to make the object. (When an object is really simple, you can tell a lot about how to make it just by looking at it.)

But if you have only oral communication, and you've built a complex culture, then passing your culture along would be like playing the game Telephone. You'd be constantly in danger of having distortions come into the transmission process, ruining the knowledge you're trying to pass along. The only way to keep this from happening would be to develop a strict habit of repeating each piece of knowledge over and over again, back and forth, to make sure the person or dolphin you're transmitting to has received an exact copy of your message, not an approximation.

Smart, but Different

I think animals are smarter than we know. I also think a lot of animals probably have a different *kind* of intelligence than *g,* the general fluid intelligence normal people have.

In the last chapter I said that animals are cognitive specialists. They're smart in some things, not smart in others. People are generalists, meaning that a person who's smart in one area will be smart in others, too. That's what IQ tests show.

Autistic people are smart the way animals are smart. We're specialists. Autistic people can have IQ scores all over the map. Donna Williams, an autistic woman from Australia who wrote a memoir called *Nobody Nowhere,* has written that her own scores on the different subscales range all the way from mentally retarded to genius. I believe it.[4]

After many years observing animals and living with autism, I have

come to the conclusion that animals with extreme talents are similar to autistic savants.

If you've never met an autistic savant, you might want to watch the movie *Rain Man,* which is about an autistic savant, Raymond, and his brother. Raymond couldn't fix himself a piece of toast without setting the kitchen on fire, but he could count cards in a game of blackjack and win thousands of dollars. That kind of disparity is typical with autistic savants. When you get outside their specialty they're almost never as smart or capable as normal people. That's why they used to be called *idiot savants.* Just like animals with extreme talent, autistic savants can *naturally* do things no normal human being can even be *taught* to do, no matter how hard he tries to learn or how much time he spends practicing. Yet they usually have IQs in the mentally retarded range.

I think we're letting a huge amount of talent go to waste, both in people who aren't "normal" and in animals who are. That's probably because we don't really understand what animals could do if we gave them a chance. We're just leaving it up to animals like the seizure alert dogs to invent their own jobs.

Autistic Savants

I mentioned at the beginning of this book that I think animal genius is probably the same thing as autistic savantry. I've felt this way for years, just from being around animals and observing them, and I mentioned it in *Thinking in Pictures.* But I didn't know why autistic genius and animal genius looked so similar to me, or whether autistic genius and animal genius might come from the same difference in the brain.

It's not that autistic savants and *animal savants* do the same things. Animal savants show brilliance when they learn complicated migratory routes after just one flight or discover how to perceive seizures before they happen. Autistic savants do lightning-fast calendar or prime number calculations inside their heads, or become artistic savants who can make almost perfect line drawings of buildings and landscapes from memory, often starting from a very young age—*and using perfect perspective.* That's especially amazing, because even great artists have to be taught how to draw using perspective. A four-year-old autistic savant just naturally knows how to do it.

Even though autistic savantry and animal savantry seem so different on the surface, the one thing that did jump out was that a lot of these talents involve amazing feats of rote memory. Autistic people are known for their ability to memorize whole train schedules, the capitals of every country in the world, and so on. Autistic savants are the only people who seem like they could give a Clark's nutcracker a run for its money when it comes to remembering where they hid thirty thousand pine seeds. But beyond that, I didn't know why animal genius felt so familiar to me.

Then in 1999 Dr. Allan Snyder, a psychologist at the Centre for the Mind at Australian National University, published a paper that laid out a *unified theory* of all the different savant talents. If his theory is right, it probably explains animal genius, too.[7] Dr. Snyder and his co-author, Dr. D. John Mitchell, say that *all* the different autistic savant abilities come from the fact that autistic people don't process what they see and hear into unified wholes, or *concepts,* rapidly the way normal people do.

A normal person looks at a building and his brain turns all the hundreds and thousands of building pieces coming in through his sensory channels into one unified thing, a building. The brain does this automatically; a normal person can't *not* do it. That's why a common drawing lesson art teachers use is to have art students turn a picture upside down and copy it that way, or else draw the *negative space* surrounding an object instead of the object itself. Turning the object upside down or drawing the negative space tricks your brain into letting the image stay in separate pieces more easily,[8] so you can draw the object instead of your *unified concept* of the object. People are always amazed at how good their upside-down drawings are.

Autistic people are stuck in the *pieces* stage of perception to a greater or lesser degree, depending on the person. Donna Williams, the autistic woman who wrote the book *Nobody Nowhere,* says she can't really see a whole object all at once. She sees a kind of slide show of the object. If she's looking at a tree, first she might see a branch on that tree, then the screen changes and she sees a bird sitting on the branch, then the screen changes again and she sees some leaves, and so on. Some autistic people have this problem a lot worse than others, and I think it's possible some autistic people have such fragmented sensory systems that they may be almost blind or deaf. I wonder whether some autistic people are so deprived of coherent sensory input that they are like autistic Helen Kellers.

Snyder and Mitchell say that the reason autistic people see the pieces of things is that they have *privileged access* to *lower levels of raw information.* A normal person doesn't become conscious of what he's looking at until after his brain has composed the sensory bits and pieces into wholes. An autistic savant is conscious of the bits and pieces.

That's why autistic savants can make perspective drawings without being taught how. They're drawing what they see, which is all the little changes in size and texture that tell you one object is closer up and another object is farther away. Normal people can't see all those little changes without a lot of training and effort, because their brains process them unconsciously. So normal people are drawing what *they* "see," which is the finished object, after their brains have put it all together. Normal people don't draw a dog, they draw a *concept* of a dog. Autistic people draw the dog.

It's ironic that we always say autistic children are in their own little worlds, because if Dr. Snyder is right it's normal people who are living inside their heads. Autistic people are experiencing the actual world much more directly and accurately than normal people, with all their inattentional blindness and their change blindness and their every-other-kind-of-blindness. (Dr. Snyder hasn't talked about inattentional or change blindness that I know of, but the research on those concepts supports his work.)

Math savants use this same brain difference to do calendar calculations and prime number identification. An autistic savant who can tell you on what day you were born is seeing time as a sequence of seven different days repeating over and over again going back to the beginning of time. They quickly scan back over the pattern until they come to your day.

Normal people don't experience time that way. To a normal person a month or a year or a decade is one unified time span, not a collection of separate and distinct days. It's a blur. (Dr. Snyder's theory is a little more complicated than I've been making it sound. He thinks the brain has a processor that divides all incoming data—time, space, objects, and so forth—into equal parts. That's why an autistic savant can tell whether a number is prime or not, because a prime number *can't* be divided.)

Calendar calculation is the hidden figure talent all over again. I believe most or even all of the savant talents autistic people have are variations on the hidden figure ability.

I also believe that most or even all of the savant talents animals have are variations on the hidden figure ability, and in just the past couple of years Dr. Snyder and Dr. Bruce Miller, a physician at the University of

California at San Francisco, have supplied some hard evidence that I may be right. Dr. Miller works with patients who have a disorder called *frontotemporal dementia* in which the front part of the brain progressively loses its functions. In frontotemporal dementia the frontal lobes and the temporal lobes, which are at the side of your head, are affected.[9] Neither of these areas is working well in autistic people either, and as I've been saying throughout this book, the biggest area of difference between the animal brain and the human brain is that an animal's frontal lobes are smaller and less well developed than a human's. Serious frontal lobe damage is worse than being autistic. If your frontal lobes are badly damaged you can have symptoms of practically all the psychiatric disorders—autism, ADHD, obsessive-compulsive disorder, severe mood disorders, you name it.

You're probably going to have at least *some* autistic symptoms. We know that Dr. Miller's patients do, because some of them start to develop savant talents. A few of these people have become artists in their fifties and sixties, even winning awards in art shows. Others have developed musical abilities; one patient invented a chemical detector and got a patent for it. When he made his invention he could name only one out of fifteen objects on a standardized word test. A patient who had lost *all* his language ability designed sprinklers! These patients had *sudden-onset* talents.

I suspect what's happening with these people is that all of a sudden they're able to have the same kind of hyper-specific perception that underlies an autistic savant's ability to do a calendar calculation or make a perspective drawing without being taught.

Dr. Snyder has now begun to test the proposition that savant talents come from conscious access to the raw data of the brain. When he uses magnetic stimulation to interfere with frontal lobe functioning in his subjects, they start to make much more detailed drawings than they could just moments before.[10] They also get better at proofreading. Before he turns on the magnetic stimulation, Dr. Snyder has his subjects read this poem out loud:

A bird in the hand
is worth two in the
the bush

Almost all people look at the poem and say, "A bird in the hand is worth two in the bush."

About five minutes after he turns on the magnetic stimulation some of his subjects suddenly read, "A bird in the hand is worth two in the *the* bush." The duplicate "the" pops out at them as their left frontal-temporal lobes go down, and they start turning into hidden figure specialists, perceiving detail they didn't perceive before. One of them even told Dr. Snyder that he felt more "alert" and "conscious of detail." He was so intensely aware of the details around him that he said he wished they had asked him to write an essay, something he normally didn't like to do.

The Devil Is in the Details

I don't know whether extreme talents in animals work the same way Dr. Snyder thinks they work in people with autism, but we have a lot of evidence that animals at least *see* the world in sharper detail than regular people do. I've already talked about how important visual detail is to animals, but we also have some fascinating research on ant navigation that goes along with Dr. Snyder's experiments.

When ants walk through an obstacle course they use landmarks to remember their route the same way people do. If they pass a gray pebble going one way, they'll look for that same gray pebble coming back.

But there's one big difference. When an ant reaches a landmark, he does something normal people don't do. He passes the landmark, stops, turns around, and *looks at the landmark from the same spot where he saw it on the trip out.*

He has to do that, because to an ant a gray pebble probably looks different coming and going. He has to see the pebble from the same vantage point where he saw it first to make sure it's still the same gray pebble he saw before. This says to me ants probably don't automatically combine separate pieces of sensory data into wholes in the same way or to the same degree normal humans do.

For a nonautistic person, a landmark looks the same coming or going. When a normal person sees a big red barn on the way to someone's house, he automatically sees the same big red barn on the way back. It looks the same to him, even though he's seeing it from a different side.

That's because a normal person's nervous system gets rid of a lot of detail and then fills in the blanks with whatever he *expects* to see. If he were consciously seeing what's really in front of his eyes, he'd see a slightly different red barn coming and going, because the south side of a barn doesn't look exactly like the north side of a barn, and the east side doesn't look exactly like the west side. Even if the builder designed all four sides to be identical, in nature there's always a difference in light and shadow.

I do the same thing ants do, which is one more thing that makes me think hyper-specificity is a key link between animals and autistic people. When I drive someplace I've never been before I look for landmarks along the road the same way everyone else does. But then when I'm driving back, the landmarks I've picked out all look different to me. I have to drive past each landmark until I reach the spot where I was when I first saw it; then I turn around and look at it from the original angle to make sure it's the same thing I saw on my way out. For animals and for people with autism, different sides of the same object actually *look different.*

Thinking About What Animals Can Do, Not What They Can't

I hope we'll start to think more about what animals *can* do, and less about what they can't. It's important, because we've gotten too far away from the animals who should be our partners in life, not just pets or objects of study.

You always hear that humans domesticated animals, that we turned wolves into dogs. But new research shows that wolves probably domesticated people, too. Humans *co-evolved* with wolves; we changed them and they changed us.

The story of how researchers have begun to piece this together is an example of *converging lines of evidence,* which is what happens when findings from different fields start to fit together and all point in the same direction. For a long time, the best evidence researchers had about when and how wolves turned into dogs came from

archaeological discoveries of dog remains that had been carefully buried underneath humans' huts. Some archaeologists found dogs and people buried together in the same grave.

Those first buried dogs date back about 14,000 years. Humans had not yet invented farming at that time, but they had the same bodies and brains we do. So it made sense to conclude that primitive humans evolved into modern humans first, then began to associate with wild wolves who subsequently evolved into the domestic dog, in order to serve as working dogs and pets.

But a study by Robert K. Wayne and his colleagues at UCLA of DNA variability in dogs found that dogs had to have diverged from wolves as a separate population 135,000 years ago.[11] The reason the fossil record doesn't show any dogs with humans before 14,000 years ago is probably that before then people were partnered with wolves, or with wolves that were evolving into dogs. Sure enough, fossil records do show lots of wolf bones close to human bones before 100,000 years ago.

If Dr. Wayne is right, wolves and people were together at the point when *homo sapiens* had just barely evolved from *homo erectus.* When wolves and humans first joined together people only had a few rough tools to their name, and they lived in very small nomadic bands that probably weren't any more socially complicated than a band of chimpanzees. Some researchers think these early humans may not even have had language.

This means that when wolves and people first started keeping company they were on a lot more equal footing than dogs and people are today. Basically, two different species with complementary skills teamed up together, something that had never happened before and has really never happened since.

Going over all the evidence, a group of Australian anthropologists believes that during all those years when early humans were associating with wolves *they learned to act and think like wolves.*[12] Wolves hunted in groups; humans didn't. Wolves had complex social structures; humans didn't. Wolves had loyal same-sex and nonkin friendships; humans probably didn't, judging by the lack of same-sex and nonkin friendships in every other primate species today. (The main relationship for chimpanzees is parent-child.) Wolves

were highly territorial; humans probably weren't—again, judging by how nonterritorial all other primates are today.

By the time these early people became truly modern, they had learned to do all these wolfie things. When you think about how different we are from other primates, you see how doglike we are. A lot of the things we do that the other primates don't are dog things. The Australian group thinks it was the dogs who showed us how.

They take their line of reasoning even further. Wolves, and then dogs, gave early humans a huge survival advantage, they say, by serving as lookouts and guards, and by making it possible for humans to hunt big game in groups instead of hunting small prey as individuals. Given everything wolves did for early man, dogs were probably a big reason why early man survived and Neanderthals didn't. Neanderthals didn't have dogs.

But dogs didn't just help people stay alive long enough to reproduce. Dogs probably also made it possible for humans to pull ahead of all their primate cousins. Paul Tacon, principal research scientist at the Australian Museum, says that the development of human friendship "was a tremendous survival advantage because that speeds up the exchange of ideas between groups of people." All cultural evolution is based on cooperation, and humans learned from dogs how to cooperate with people they aren't related to.[13]

Maybe the most amazing new finding is that wolves didn't just teach us a lot of useful new behaviors. Wolves probably also changed the structure of our brains. Fossil records show that whenever a species becomes domesticated its brain gets smaller. The horse's brain shrank by 16 percent; the pig's brain shrank as much as 34 percent; and the dog's brain shrank 10 to 30 percent. This probably happened because once humans started to take care of these animals, they no longer needed various brain functions in order to survive. I don't know what functions they lost, but I do know all domestic animals have reduced fear and anxiety compared to wild animals.

Now archaeologists have discovered that 10,000 years ago, just at the point when humans began to give their dogs formal burials, the human brain began to shrink, too. It shrank by 10 percent, just like the dog's brain. And what's interesting is what *part* of the human brain shrank. In all of the domestic animals the *forebrain,* which

holds the frontal lobes, and the *corpus callosum,* which is the connecting tissue between the two sides of the brain, shrank. But in humans it was the *midbrain,* which handles emotions and sensory data, and the *olfactory bulbs,* which handle smell, that got smaller while the corpus callosum and the forebrain stayed pretty much the same. Dog brains and human brains specialized: humans took over the planning and organizing tasks, and dogs took over the sensory tasks. Dogs and people coevolved and became even better partners, allies, and friends.

"Dogs Make Us Human"

The Aborigines have a saying: "Dogs make us human." Now we know that's probably literally true. People wouldn't have become who we are today if we hadn't co-evolved with dogs.

I think it's also true, though in a different way, that *all* animals make us human. That's why I hope we'll start to think more respectfully about animal intelligence and talent. That would be good for people, because there are a lot of things we can't do that animals can. We could use their help.

But it would be good for animals, too. Dogs first started living with people because people needed dogs and dogs needed people. Now dogs still need people, but people have forgotten how much they need dogs for anything besides love and companionship. That's probably okay for a dog who's been bred to be a companion animal, but a lot of the bigger breeds and practically all of the mixed breeds were built for work. Having a job to do is part of their nature; it's who they are. The sad thing is, now that hardly anyone makes his living herding sheep, most dogs are out of a job.

It doesn't have to be that way. I read a little story on the Web site for the American Veterinary Medical Association that shows the incredible things animals are capable of doing, and would do if we gave them the chance. It was about a dog named Max who had trained himself to monitor his mistress's blood sugar levels even while she was asleep. No one knows how Max was doing this, but my guess is people must smell slightly different when their blood sugar is low, and Max had figured that out.[14] The lady who owned him was a severe diabetic, and if her blood sugar levels got low during the night Max would wake up her husband and bug him until he got up and took care of her.

You have to think about that story for only five seconds to realize how much dogs have to offer. Dogs and a lot of other animals.

—

People always wonder how I can work in the meatpacking industry when I love animals so much. I've thought about this a lot.

After I developed my center-track restraining system, I remember looking out over the cattle yard at the hundreds and hundreds of animals milling around in their corrals. I was upset that I had just designed a really efficient slaughter plant. Cows are the animals I love best.

Looking at those animals I realized that none of them would even exist if human beings hadn't bred them into being. And ever since that moment I've believed that we brought these animals here, so we're responsible for them. We owe them a decent life and a decent death, and their lives should be as low-stress as possible. That's my job.

Now I'm writing this book because I wish animals could have more than just a low-stress life and a quick, painless death. I wish animals could have a *good* life, too, with something useful to do. I think we owe them that.

Another reason I'm writing this book is that I want to inspire more young people to do what I do. I am worried about who is going to replace me. There is a great need for more students to get involved with working hands-on in the field. The most powerful agent of real constructive change is often a person who has both high-level university training and practical experience. The hands-on field experience keeps the person grounded in reality, but higher education provides the knowledge that will enable the person to develop effective practical solutions for problems. Good fieldwork sometimes requires months or weeks of sustained hard work. My work is tiring, stressful, and dirty, but it is also highly rewarding to

see progress and to know that I have helped improve the quality of life for many animals.

I don't know if people will ever be able to talk to animals the way Doctor Doolittle could, or whether animals will be able to talk back. Maybe science will have something to say about that.

But I do know people can learn to "talk" to animals, and to hear what animals have to say, better than they do now. I also know that a lot of times people who can talk to animals are happier than people who can't. People were animals, too, once, and when we turned into human beings we gave something up. Being close to animals brings some of it back.

BEHAVIOR AND TRAINING TROUBLESHOOTING GUIDE

Training, solving behavior problems, and understanding why animals do what they do will be easier if you know the motivations for different behaviors.

Animal behavior is a complex mixture of learned behaviors, biologically based emotion, and hardwired instinctual behavior.

Examples of hardwired behaviors are bird mating dances and a dog chasing something that moves rapidly. Ethologists call these behaviors, which are always the same and never vary from one member of a species to another, fixed action patterns. Fixed action patterns are turned on by sign stimuli. The sign stimulus for prey chasing is rapid movement, while a bird's mating dance is triggered by the sight of a potential mate as well as a surge of hormones.

The fixed action pattern is hardwired but the particular sign stimulus that turns it on is determined by learning and emotion. A basic principle of animal behavior is that WHO you have sex with, WHAT you eat, WHERE you eat, WHO you fight with, and WHO you socialize with are *learned.* In dogs the killing bite is instinctual, but the animal learns what to kill and what not to kill. Chasing things that move rapidly is instinctual, but a dog learns that he *can* chase a ball but he *cannot* chase children.

Brain research now shows that the way the brain processes various core motivations, or emotions, is different. Example: fear and rage are neurologically very different. Being scared and being angry are two different feelings. Both humans and mammals have similar systems in the brain for processing basic emotions.

Another important principle in shaping animal behavior is the fact that animals are individuals. One dog may have high social motivation and respond well to praise alone. Another dog may be more motivated by food rewards. The degree of fearfulness varies greatly between different breeds of animals, but the range of fearfulness within the same breed may also vary greatly. On average, Arab horses and Border collies have higher fearfulness than quarter horses and Rottweilers, but there will be some low-fear Arabs who will have the lower fear levels of a quarter horse.