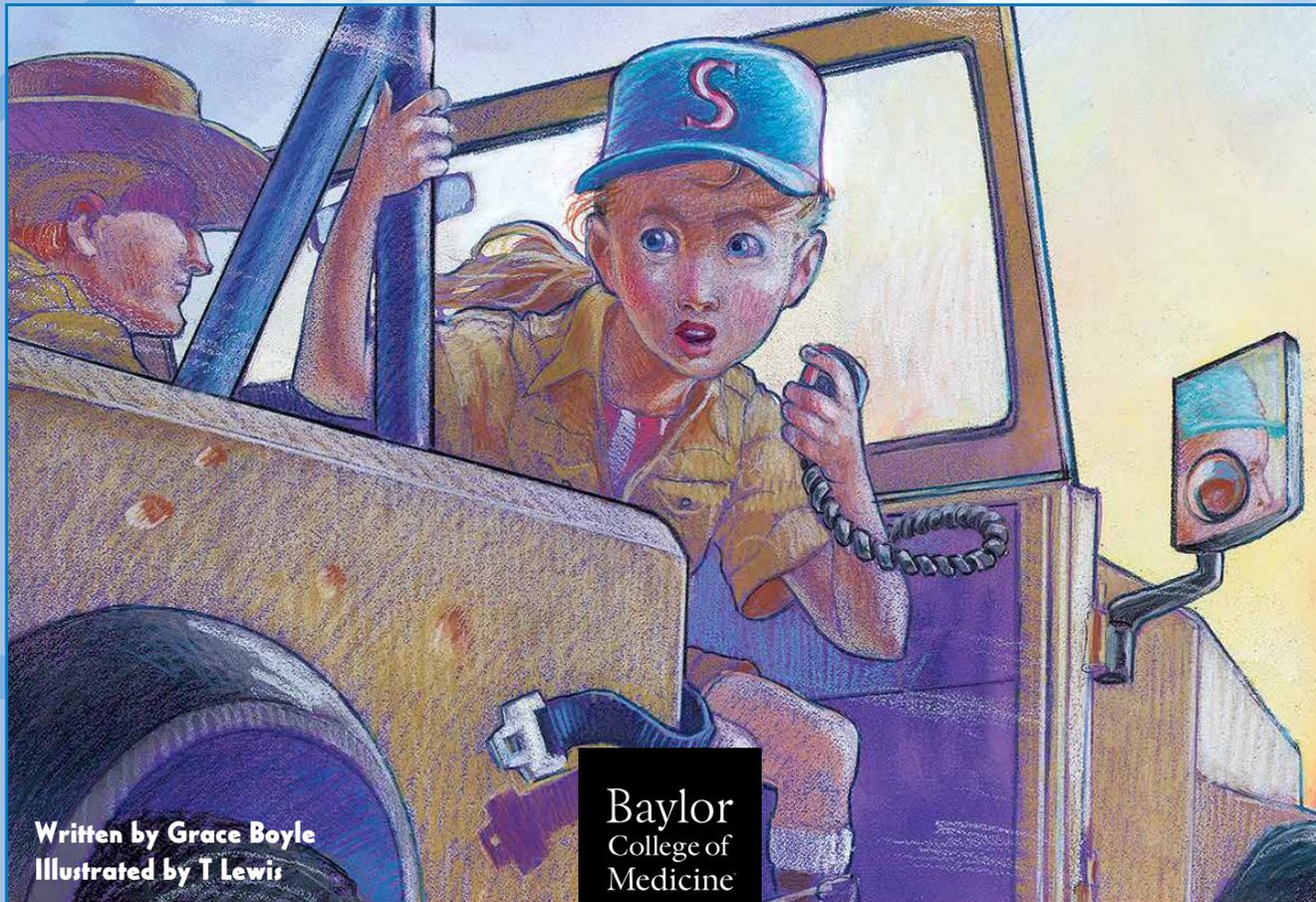




THE MOTOR SYSTEM

# TROUBLE AT TSAVO

The Tale of the Black Rhino



Written by Grace Boyle  
Illustrated by T Lewis

Baylor  
College of  
Medicine





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Written by Grace Boyle

Illustrated by T Lewis

Revised by Barbara Tharp and Judith Dresden

Science notations by Nancy Moreno



BioEd Teacher Resources from the  
Center for Educational Outreach  
Baylor College of Medicine

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## BioEd<sup>SM</sup>

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## How the NeuroExplorers Club Began

All Josh Kavil saw was the stop sign. The next thing he remembered was waking up in the hospital. He had been riding his bicycle without a helmet and was struck by a car. His skull was fractured, and his brain was badly damaged.

Some good came of Josh's unfortunate accident. Once he recovered, he remembered never to ride without a helmet. His misfortune also was the beginning of the NeuroExplorers.

When Josh's friends came to visit him at Worthington Regional Hospital, some of them became fascinated with the field of neuroscience. On their visits, they met a neurosurgeon, a neurosurgical nurse, a neurologist and a neuroradiologist.

These medical specialists help patients who have problems involving the brain or other parts of the nervous system.

It was Kyle Camacho's idea to form the club. The members wanted to know more about the nervous system. They also liked to solve puzzles and riddles and had an interest in investigating some of the mysteries of science.

Since they formed the club, the NeuroExplorers have volunteered at a rehabilitation center for brain injury patients, held a Neuroscience Fair at their school and spent a day in the hospital on rounds with a neurologist. They have learned a lot about how the brain and nervous system work, and they always are looking for exciting things to do with neuroscience.

**Neuroscientists study the brain and the rest of the nervous system. The basic building block of the nervous system is the nerve cell, or neuron. The word "neuron" comes from the Greek word for "nerve." How many words can you find that start with "neuro-"?**



## The NeuroExplorers



### **B.J.**

B.J. Armstrong spends a lot of time with her drums. In fact, she carries her drumsticks with her and uses them on any hard surface she can find! She wants to play in a band, but she also wants to be a physician. B.J. has two brothers who sometimes act as advisors to the NeuroExplorers. One brother is a neurologist at a medical school. Her brothers never liked to use her formal name, Beverly Jane, so they always call her B.J., and so do her friends.



### **Kyle**

Kyle Camacho's father is an archaeologist at Dargate University and often is away on digs. Last year, he took Kyle with him on a short dig in Belize. Kelly, Kyle's sister, sometimes does things with the NeuroExplorers, although some of the members feel that she is a little young for the club. Kyle likes to read science fiction books, solve puzzles and play computer games. His hobby is memorizing fascinating trivia.



### **Lakeisha**

Lakeisha Crawford wants to be a chess grandmaster, so she carries a pocket chess game around with her. She often thinks about things in terms of chess problems, and she has developed a good memory, and has easy recall of facts and figures. She also likes to play other games and sports. She loves hiking and snowboarding, but karate lessons are her latest passion. Lakeisha's little sister has epilepsy.



### **Josh**

When Josh Kaval recovered from the head injuries he received in a bicycle accident, he couldn't wait to join the club with his friends. Josh has always liked science, because he loves to figure out how things work. He also loves animals. He has a pet lizard named Scooter, a snake named Slim, two dogs and two cats. After his experience as a patient in a rehabilitation center, he decided he would like to be a physical therapist when he grows up.

**Max**

Max Miller has been friends with Antonio, “The Brain” since they were babies, and that’s why he understands him so well. They spend most of their time together. While The Brain reads, Max often works on models of boats and planes or builds things with wood. Max became interested in neurology when his grandfather had trouble with his memory and was diagnosed with Alzheimer’s disease.

**Shiloh**

Shiloh Nimbus lived on a game reserve in Africa for many years. While there, her back was injured, and now she must use a wheelchair. Before her injury, Shiloh was very athletic. Now she has become an excellent wheelchair tennis player. She also likes to put together jigsaw puzzles with thousands of pieces. Shiloh was happy to make friends with the NeuroExplorers when she came to her new school in America.

**Antonio “The Brain”**

When Antonio Velasquez-Ruiz was a toddler, he was very quiet and never tried to talk. One day he suddenly began speaking in complete sentences. Since then, he has been known as the smartest boy in town. The trouble is, only his best friend can understand The Brain’s big words and long sentences. The Brain reads a lot, but his most-used books are a very fat dictionary, a set of encyclopedias, and *Gray’s Anatomy* (of the human body).

**The Twins: Isley I and Isley II**

Identical twins, Isley I and II (even their parents don’t call them by their actual first names) are always kidding each other. They both love sports and play soccer, baseball and basketball. Isley I collects baseball cards and has a 1954 Mickey Mantle in good condition. Isley II holds the record for consecutive basketball free throws in his school. Their father, a bird-watcher, got them interested in science by reading to them about Charles Darwin.



## Tennis Anyone?

The NeuroExplorers watched Shiloh Nimbus play tennis. Her overhead smashes and perfectly placed shots left them gasping with wonder and cheering in amazement. Back and forth the ball went over the net, and most of the points were won by Shiloh. Her opponent was good too, but Shiloh Nimbus was one of the best tennis players Kyle, Lakeisha, Max, The Brain, B.J. and the Isley twins had ever seen. The game was so intense that, after a few minutes, the NeuroExplorers didn't even notice the players' wheelchairs.

## A Call to Order

Later, back at Kyle Christian's house, The Brain had an annoyed look on his face. "I apologize for the cacophony," he said to Shiloh.

Shiloh looked at him blankly. Although she was one of the top students in her class and prided herself on her vocabulary, she was baffled. Fortunately, Max was standing over her shoulder.

"He's sorry there's so much noise in here," Max said to Shiloh. "Don't worry about The Brain. You'll get used to him. He's really a nice fellow. He just likes to use big words."

Shiloh nodded. She might have spoken if she thought she would have been heard.

It was always noisy just before a NeuroExplorers' Club meeting, especially when held in Kyle's basement. The drumming sound was B.J., attached to her headphones, drumsticks flailing, knocking out a rhythm on the back of a chair. Periodic crashes shook the floor—the Isleys were wrestling. Lakeisha was fiddling with an old TV in the back of the room. Even Kyle contributed to the noise, trying to tell Shiloh about the NeuroExplorers' last great adventure—their search for the skull of the Mishigara Man in the Caves at Calicoon.

Finally, The Brain couldn't take any more. "Could we restrain the clamor?" he asked. Nobody noticed. The Brain cleared his throat and spoke slightly louder. "We cannot commence until this riot is subdued," he said.

Still no response. Max was getting ready to help.

"*Quiet!*" The Brain shouted, instantly freezing the NeuroExplorers.

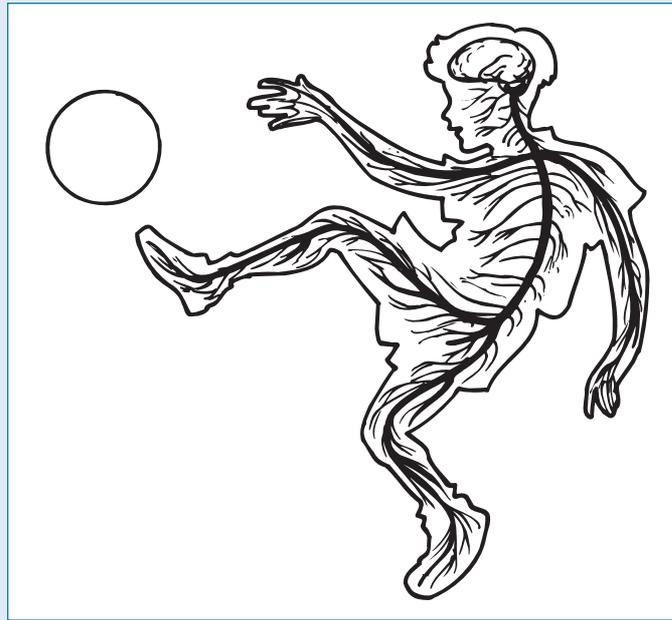
"No need to translate that," Max said with a smile. "Let's start the meeting."



## A New NeuroExplorer

The meeting was going well. Although they had no big projects, the NeuroExplorers had one exciting piece of business. Their new friend, Shiloh Nimbus, was becoming a member. Sitting around the basement, the NeuroExplorers wanted to ask Shiloh some questions, but it was difficult to find the words.

Our nervous system and muscles must work together for us to move. Signals for movement start in the brain or spinal cord. The messages are carried along special cells, called neurons, to the muscles. When the spinal cord or other parts of the nervous system are damaged, some or all of these messages can't get through.



Shiloh sensed their curiosity. “You’re probably wondering why I need to use a wheelchair,” she said.

The NeuroExplorers remained silent.

“I don’t mind talking about it, really,” Shiloh continued.

“I heard it was a diving accident,” said Isley I.

“I heard it was a car accident,” said Isley II.

“A gunshot?” B.J. asked.

“I thought you were born that way,” Lakeisha added.

Shiloh laughed, “I knew there were rumors—but I didn’t know there were so many different ones!”

“I think most of the rumors started because you were new in school this year,” Kyle said, “and, well, everybody noticed you . . . and . . .”

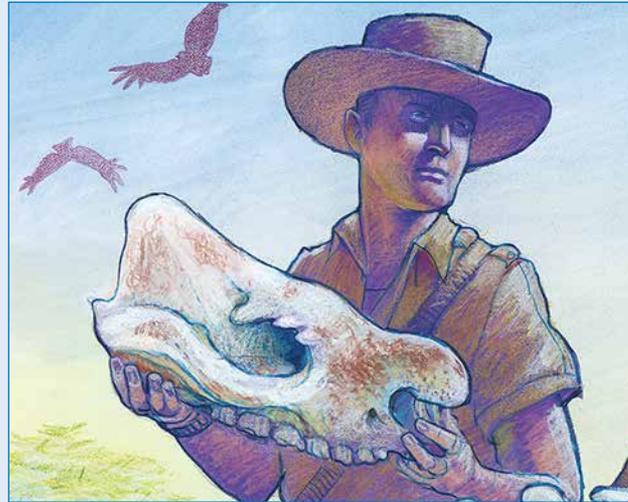
Shiloh nodded her head. “Yes, I know,” she said. “Anyway, my family just moved back to the United States from Kenya.”

“Kenya?” Lakeisha asked, amazed. “Africa? Wow! Why were you in Africa?”

“My father is a zoologist who specializes in large, exotic animals. He worked for the Kenyan government in one of their game parks for twelve years,” Shiloh answered.

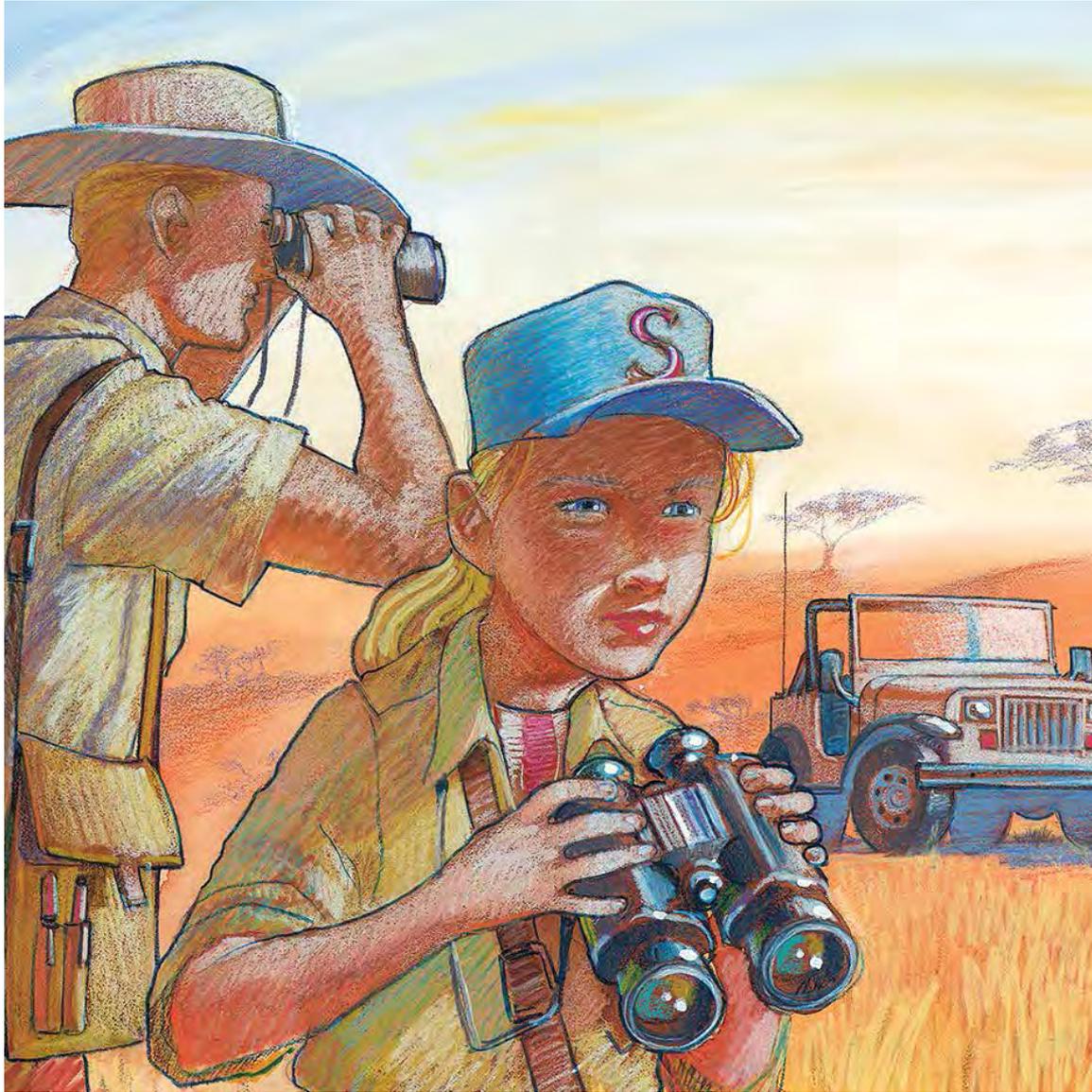
B.J. looked confused. “Large, exotic animals?” she said aloud.

“Right,” Shiloh said, “like elephants, giraffes



Shiloh’s father is a zoologist, a biologist who studies animals. Biologists look for answers to many different kinds of questions about living organisms. Shiloh’s father, for example, is interested in learning about how rhinos live in their natural environments. Other biologists study things that can be seen only with a microscope or that happen inside cells

Neuroscientists are biologists who ask questions about all aspects of the nervous system, such as how nerve cells carry messages and how the brain processes information. What other kinds of biologists can you name?



and rhinoceroses. There is one type of rhinoceros that Dad is especially interested in—the black rhino.”

“The black rhinoceros!” The Brain repeated, his eyes flashing delight. “A majestic creature, hunted almost to extinction for the harvest of its horn.”

“That’s right,” Shiloh said, “and the black rhino always will have special meaning to me. It’s because of the black rhino that I’m paralyzed.”

The NeuroExplorers sat in tense silence, waiting for Shiloh to continue. Frightening pictures of huge, angry rhinos, and who knows what else, ran through their brains as they gathered courage to hear the rest of the story. What terrible thing had happened to Shiloh Nimbus? And how was the black rhinoceros involved?

## Poachers at Tsavo\*

Shiloh began to tell her story. “My father would take me with him on some of his expeditions near our home in Kenya. We’d pack our tent and supplies and set off in the jeep to track the animals.”

“Did you hunt them?” Isley I asked.

“Oh no!” Shiloh said. “We tagged and followed them, studied their habits and helped them if they were sick. Hunting in the preserve is against the law, and besides, my father loves those animals. He takes care of them. He would never hurt them.”

“We’ve heard stories of people hunting the big animals, even in the game preserves,” Isley II added.

“That does happen,” Shiloh said, “but the hunters are poaching—killing

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\*Tsavo is pronounced SAV-voh.

the animals illegally—and the black rhino is one of their most treasured finds. That’s what set my father and me on this expedition onto the plains of Tsavo.”

The NeuroExplorers couldn’t wait to hear more! As Shiloh began to tell about her fateful day on the Tsavo plains, the NeuroExplorers felt as if they were there.

## Trek to Moldavvi Pass

Gently, gently the wind blew as it flowed over the calm African plain. There was nothing but peace in the bright and cloudless sky. Suddenly, a herd of large animals was storming toward Shiloh, threatening to trample her.

A voice broke through her terror. “Shiloh! Come on, Shiloh, wake up,” it said. Shiloh, breathing hard, opened her eyes with a start as her father shook her shoulder. The stampede had been a dream. She exhaled slowly and began to come back to the real world.

“You’re a heavy sleeper,” her father said, smiling. Shiloh shook her head, trying to leave the rhinos behind and focus on the man in front of her.

Dr. Nimbus turned away from the sleepy girl. “Let’s go, Shiloh,” he said. “The jeep is loaded. I’d like to be in Moldavvi by nine.”

“Is that where they spotted the skeletons?” Shiloh asked.

“Yes,” said her Dad. “Maybe we can pick up some clues there. The government wants me to study the remains of the dead rhinos to see what I can learn about the poachers.”

“Poachers—,” Shiloh exclaimed, “I hope we find them!”



Trouble at Tsavo  
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“Don’t say that, Shiloh,” her father said. “We aren’t equipped to deal with a squad of armed poachers.”

The ride to Moldavvi Pass was never boring. Through low brush and grasses, patches of shrubs and low trees, Shiloh watched for the great animals. With her trusty binoculars, she searched the sky for birds. She wanted to become expert at recognizing all the different kinds.

Shiloh turned around and stood in her seat, holding on to the roll bar of the jeep while they drove. She aimed her binoculars at the sky and amazed her father with her growing ability to identify the African birds.



“Shiloh, I think you’d better sit down,” her father said as the jeep swerved and plunged through some underbrush. “And be sure to fasten your seat belt,” he added firmly.

“Oh Dad, come on,” Shiloh called back. “You’re talking to the girl who took first in the balance beam, remember? I won’t fall.” But her father’s stern look made her give in.

## A Spinal Cord Puzzle

“You were a *gymnast?*” said a surprised Isley II.

His outburst broke the spell of Shiloh’s story and transported the NeuroExplorers back from Africa. Max was fanning himself to fend off the oppressive African heat. B.J. blinked, her eyes aching from the strong Kenyan sun. The moment was undone.

“Isley, don’t interrupt!” Kyle said.

“No problem,” Shiloh replied. “Yes, I was pretty good on the balance beam and parallel bars. I’m still crazy about sports,” she continued. “Are you surprised that I can play tennis?”

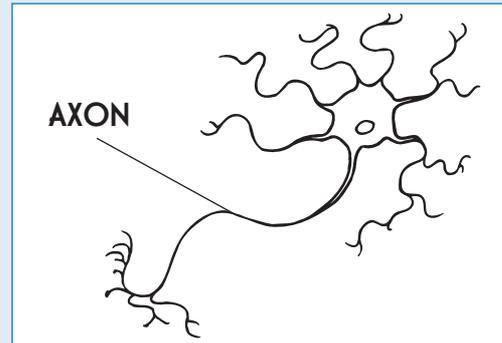
The NeuroExplorers looked at each other, unsure how to respond. Kyle finally said, “Well, I guess we were just amazed that someone in a wheelchair could get around the court and smash the ball that way.”

“The problem is just in my legs,” Shiloh said with a half-smile. “I’m paraplegic—my injury involves only my lower body. I can do anything you can do with my arms and upper body, and my sports chair helps me move around the tennis court really well.”

The Brain stood up and began to pace. “This poses a fascinating neurological puzzle that merits the club’s attention,” he said.

Billions of neurons are linked together to form the brain, the spinal cord and the rest of the nervous system. Neurons carry messages along long tails, or nerve fibers, called axons.

There are more than 10,000 kinds of neurons in our bodies.



“I don’t get it, Brain,” said Isley II.

“That’s no big surprise,” said Isley I, shoving his brother.

“Hold on, Isleys,” Max said. “The Brain means that there’s an interesting neuroscience question here for us to consider.”

“We recognize that paraplegia is paralysis below the waist,” The Brain said.

B.J. was catching on. “And quadriplegia involves more paralysis—you can’t move anything from the neck down,” she added. “I know that because my brother works in a rehab center.”

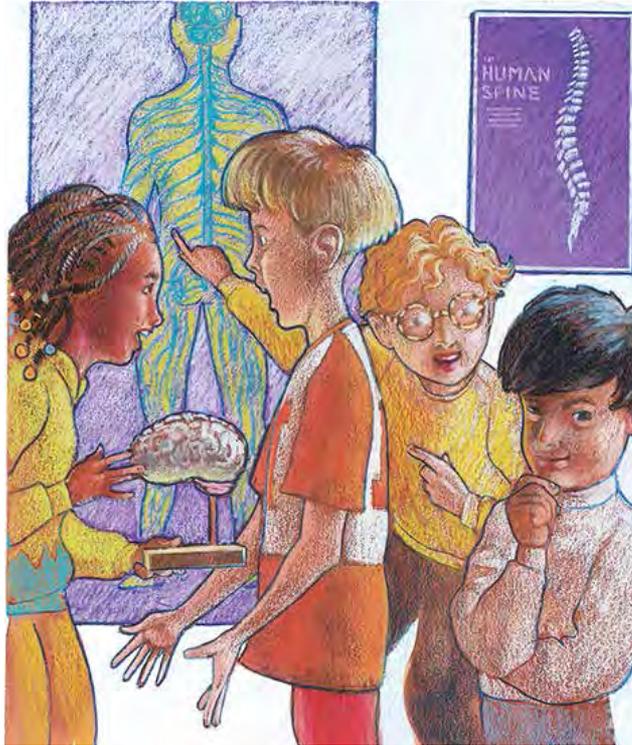
“And the brain doesn’t have to be damaged to have either of those conditions,” The Brain continued.

“The question is, what causes the difference between paraplegia and quadriplegia?” The Isleys said together.

The Isleys sat in silence. Max scratched his head. B.J. tapped on the table, trying to drum up the answer. Kyle and Lakeisha seemed stumped. Shiloh Nimbus was smiling.

“You’ve gotten right to the point,” Shiloh said to her new friends. “Paraplegia and quadriplegia usually are caused by injury to the spinal cord, not the brain. The difference between them is the *place* where the spinal cord is injured. If you damage the cord at a high level, near your neck, you can become quadriplegic. If the cord is injured at a lower level, you can become paraplegic.”

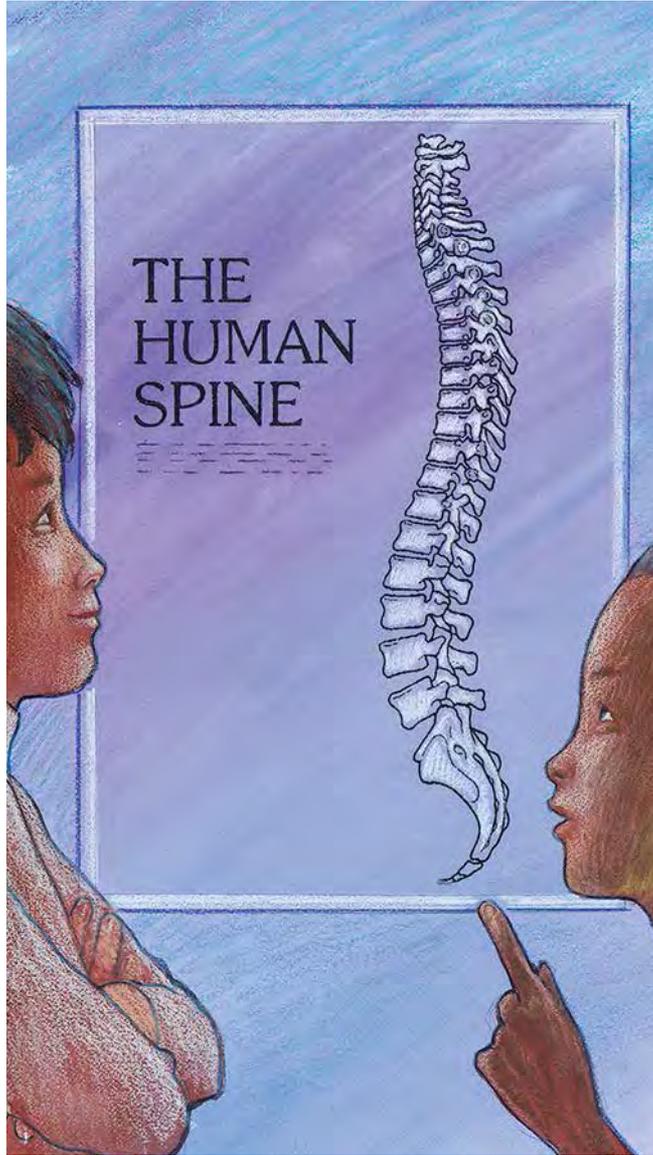
It was as if someone had turned on the lights. “Of course!” B.J. said, striking Kyle’s bicycle helmet like a cymbal. “Now I remember how it works. The orders for muscle movement start in the brain. Cells in the



brain—neurons—extend all the way to the spinal cord and carry orders to other neurons that communicate with the muscles.”

Everyone started talking at once, trying to explain the spinal cord to each other, and to themselves.

B.J. tapped out her thoughts as she spoke. The Brain paced, talking to no one. Lakeisha and Kyle ran back and forth between models and charts. Excitement was in the air. Through it all, Shiloh Nimbus sat quietly, smiling. She had found some great new kids for friends!



## A Good Question

Max finally got everyone quiet again and into their seats. Standing by a poster of the spine, Max and The Brain explained that the spinal cord lies within the protective bones of the spinal column. “All along the spinal column, motor neurons go out from the spinal cord, carrying messages for movement to the rest of the body.” Max said.

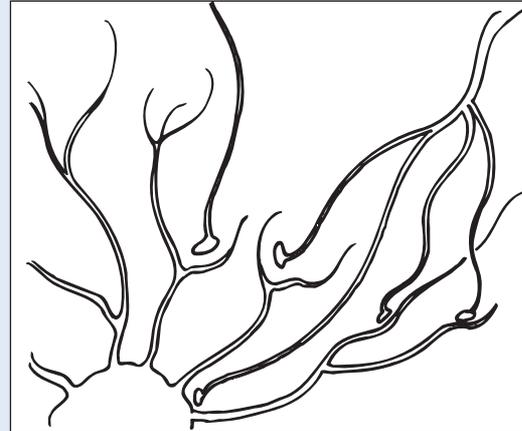
Lakeisha frowned. “But there’s something I still don’t get,” she said.

“I’m afraid I am unable to comprehend your perplexity,” The Brain said to Lakeisha.

Everyone looked at Max. “He wants to know why you’re confused,” Max interpreted.

Neurons communicate with each other by sending special chemical messengers across tiny gaps between cells. The gaps are called synapses. Neurons also can communicate via electrical synapses.

Motor neurons carry messages from the brain or spinal cord to muscles. Sensory neurons carry information back to the spinal cord and brain.



“Well, if you break your arm, the doctor puts it in a cast and it heals. If you get a cold, it goes away. When you cut yourself or pull a muscle, it gets better after a while.”

The Brain nodded and said, “I underestimated your consternation, Lakeisha. What you want to know is, why are injuries to the spinal cord permanent?”

“Right,” Lakeisha said. “I mean, *why* doesn’t it get better? Why do you have to stay paralyzed?”

The NeuroExplorers didn’t know the answer. They looked to Shiloh.

“The spinal cord doesn’t heal well,” she said softly. “Most nervous system tissue doesn’t repair itself like skin, muscles and bones do. Brain and spinal cord injuries usually are permanent.”

“But I read that there are new medicines to treat spine and brain injuries,” Isley I said.

“Yes,” said Shiloh, “there’s a new medication, a kind of steroid, that can help keep down swelling and inflammation and limit the amount of injury, if it’s given soon enough. But there really isn’t any way to repair the damage.”

The NeuroExplorers were silent for a few seconds. There was something that kept them wondering—something about Shiloh’s paralysis and her life in Kenya. A massive shape seemed to wander mysteriously among the young scientists. It was a black rhino.

Shiloh decided to continue her story.

## **The Black Rhinoceros**

White bones . . . surrounded by buzzing flies, picked clean and scattered by hyenas and vultures. Shiloh raised her arm, trying to deflect the blazing Kenyan sun. Large sun-bleached bones lay in the parched grass at her feet. She knew from her father’s expression that they had found the remains of a black rhino.

“How do you know this is a black rhino, Dad?” she asked.

“The shape of the cranium,” her father answered, handling the long, irregular skull. “It looks like a rhino, and it’s pretty safe to say it’s a black rhino, because the skull is narrower and more pointed than in its cousin, the white rhino. Black rhinos’ jaws are more pointed, too. They have to pull leaves and twigs from the trees for food. White rhinos eat short grasses, so their jaws are wider, almost like a lawnmower.”

“But where are the horns? I don’t even see a place in the skull for them,” Shiloh said. “I thought black rhinos had two horns.”

“That’s right. But they aren’t true horns, made of bone,” Dr. Nimbus said. “They’re made of densely compacted hair-like fibers and, unfortunately, “You



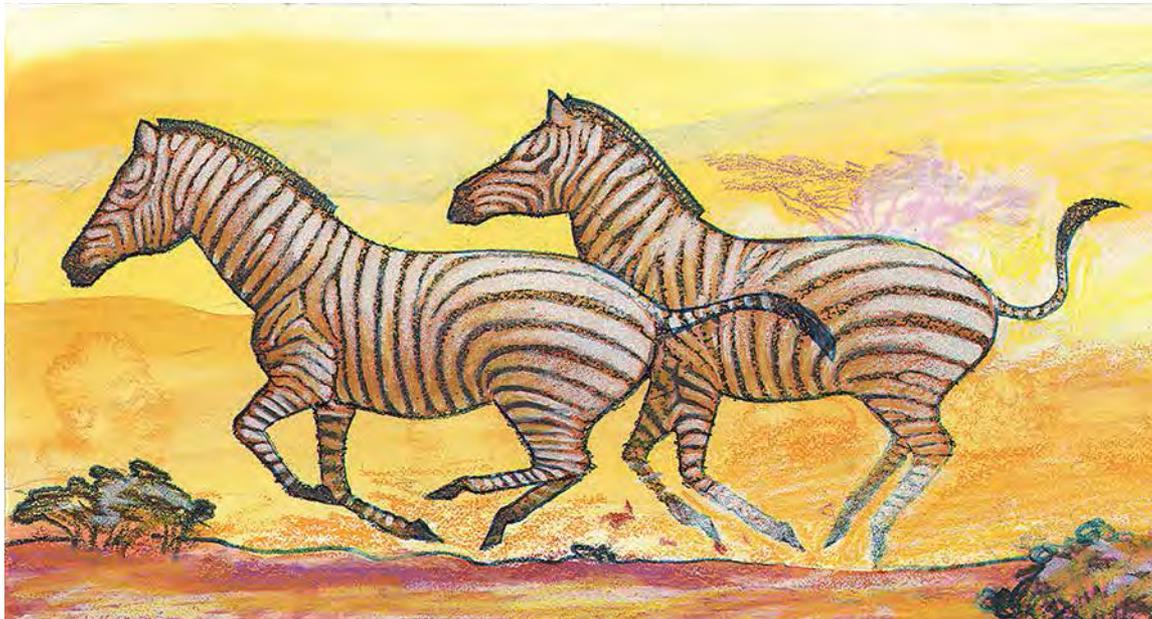
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they're very valuable to some people. That's the only reason people kill these animals—for their horns. This definitely is the work of poachers. They kill the animal, then remove the horns and leave the carcass. They don't use the meat or the hide—just the horns.”

“It makes me so angry! They could just sedate the animal and cut the horns off with a saw, if they have to have them. Then the rhino could live, and his horns would grow back.” Shiloh's father grew more and more angry as he shouted to the sky, “The black rhino is almost *extinct* because of these senseless poachers!”

“Why do they want the horns so much, Dad?” Shiloh asked.

“They sell them to people in other countries. Some people use the horns for a special kind of dagger handle. Others grind the horn into a powder,



which they think is a potent medicine. People are willing to pay a lot of money for it,” her father answered.

“Is it a good medicine?” Shiloh asked.

“No, but that doesn’t matter,” he said. “If someone is willing to pay for the horns, the poachers will hunt the rhino anyway.”

Shiloh looked over the scene, the sun pushing down on her neck like a hot iron. As she looked at the skeletal remains, she became as angry as her father. “Do you think we can get these poachers, Dad?” she asked.

“We aren’t the police, Shiloh,” her father sighed. “We’re just here to track and identify. But we’ll stay for a day or so and see if we can turn up some evidence, or maybe find a live rhino that needs tagging or medical help.”

## Caught by Surprise

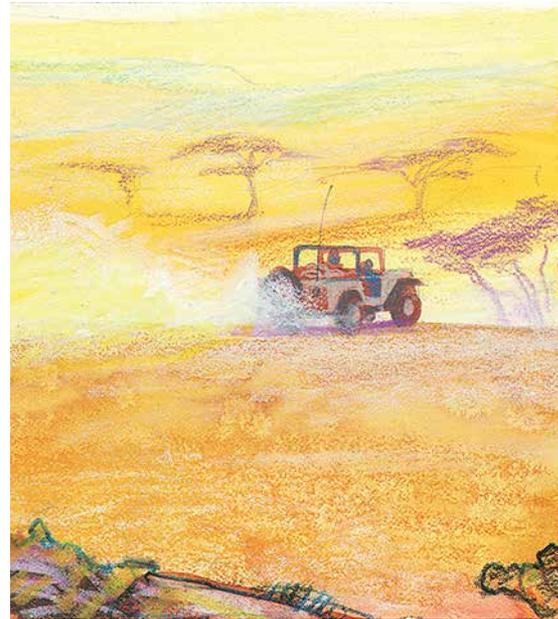
The jeep rolled slowly through the low grasses and small trees. Dr. Nimbus thought there might be a rhinoceros nearby. Fresh tracks, droppings and newly crushed branches told him that a large animal had been here not long ago.

“Shhh,” Dr. Nimbus whispered.

“What, Dad?” Shiloh whispered back.

“*There*,” he said quietly, pointing out toward the horizon.

Shiloh strained but couldn’t see



anything except the Kenyan terrain. “Where?” she asked.

“That slope beyond the last group of trees.” As he answered, he stopped the jeep, and they stepped out.

Shiloh saw the slope and let her eyes trip down the grassy knoll to the bottom. There they were—three rhinos, one larger than the others, sharing a waterhole. “Wow! Let’s get closer, Dad,” she whispered.

Dr. Nimbus didn’t have to answer. As if they had heard Shiloh’s plea, the three massive beasts lifted their heads together. They leaned forward and began to move . . . and then they started to run.

Shiloh and Dr. Nimbus stood as still as the acacia tree next to them. It was a moment before they grasped what was happening.

“Dad,” Shiloh gasped, “Are they . . . ”

*“They’re charging us!”* Dr. Nimbus screamed, grabbing his daughter by the arm and running for the jeep.

What they didn’t see, in the dust behind the rhinos, were poachers, chasing the huge beasts toward a snare—and directly toward Dr. Nimbus and Shiloh!

## On Top of the Brain

A sudden crash broke the magic web of Shiloh’s story. Max jumped. Isley I was on the floor. He had fallen off his stool.

“Isley I,” Max said, running over to help him, “what’s the matter?”

“He’s running from the rhinos,” Isley II said matter-of-factly.

It was almost true. Shiloh’s story was so real that the NeuroExplorers all had felt a surge of fear as she described the double threat of charging animals and poachers.



Trouble at Tsavo  
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“You should be on television, telling stories,” Lakeisha said to Shiloh. “You do it so well!”

“Or write a book about your adventures,” B.J. added. The NeuroExplorers all agreed.

Lakeisha looked intently at Shiloh. “It’s kind of amazing,” she said, “that you’re so good at so many things, even though . . .”

“She’s not disabled here,” a voice from the corner interrupted. The NeuroExplorers all turned to look over their shoulders. The Brain was standing in the corner, studying Kyle’s model of the brain.

“Hey, Brain, it’s like looking in a mirror, right?” Isley II said. Everyone laughed.

The motor cortex is a special part of the brain that directs the movements you choose to make. This includes things like raising your hand in class or trying out a new dance step.

The cerebellum, at the back of the brain, stores motor programs to coordinate movements that you have learned, like walking or throwing a ball.



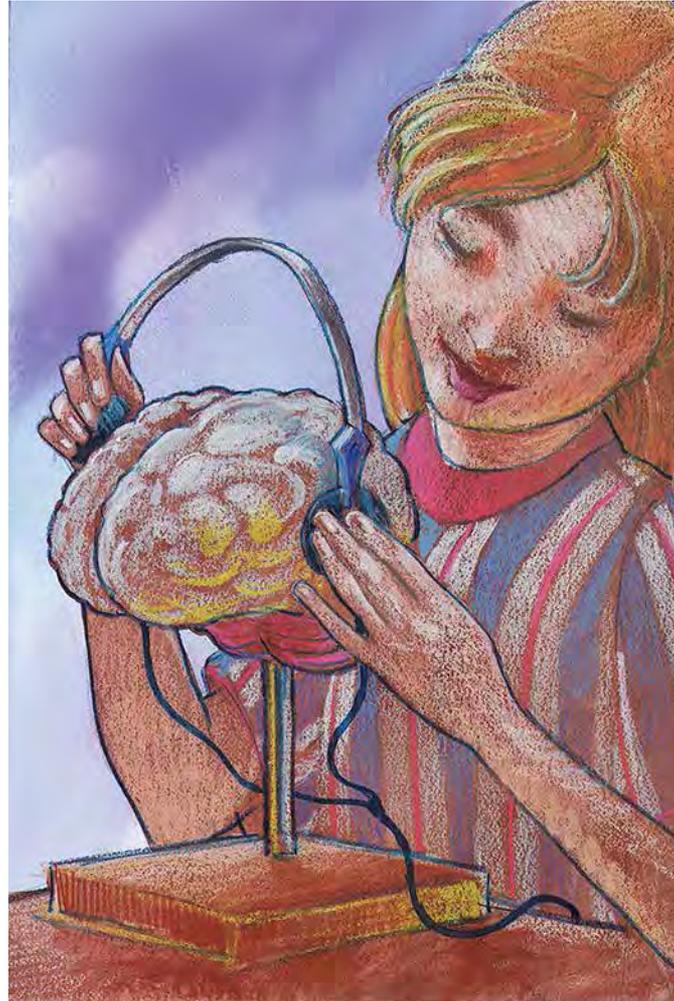
As The Brain continued to think, he ran his finger over the top of the brain.

“What are you doing, Brain?” Lakeisha asked.

“Studying the motor cortex,” The Brain answered. “That’s where the impulses for movement begin. When we think about moving our hands or feet, the impulse to carry out that action starts right here,” The Brain said, pointing, “in this strip on the top of the brain.”

“That’s the strip of the brain right under where you wear headphones!” said B.J., holding up the headphones to her music player. She placed them over the model.

“Right,” Shiloh answered, eager to be a part of the brainstorming, “and different parts of the motor cortex have special functions. Like one part controls your ankle, and one controls your face, and there’s another part for your fingers and hands.”



The NeuroExplorers all nodded, but they were eager to hear the rest of Shiloh's tale. They knew that, somewhere among the charge of the rhinos and the pursuit of the poachers, lay the answer to the mystery of Shiloh's injury.

## Rumbling Thunder

Dr. Nimbus knew two things very well—rhinos are very big and very fast! The average male rhino weighs around 4,500 pounds and can run 25 miles per hour. If you get in the way of a charging rhino, it's like getting run over by a car.

Father and daughter jumped quickly into the jeep. Dr. Nimbus gunned the engine and turned the wheel hard, ramming the vehicle through a patch of tall dried grass, the shoots cracking like brittle glass as the jeep tore through them. Beyond the dust raised by the rhinos, they could see the glint of a gun and the running feet of men who were chasing the animals. The poachers!

Dr. Nimbus floored the gas and drove away from the rhinos. He took a sharp turn, and the animals followed them.

*"Shiloh,"* he yelled above the roaring noise, "get on the radio and call the rangers. Give them our position. Tell them we need help, *fast!*"

Snatching the handset off the dash, Shiloh quickly reached the ranger station. "Shiloh Nimbus calling from Moldavvi Pass. Three rhinos spotted, chased by poachers. Chasing us! Send help!"

Shiloh got no further. Breaking out of tall grasses onto the wide-open plain, Dr. Nimbus slammed on the brakes as they held on for their lives. Two poachers had popped up in front of them.



“Dad!” Shiloh screamed. One of the poachers was pointing a rifle. The other had a bow and arrow slung low by his side.

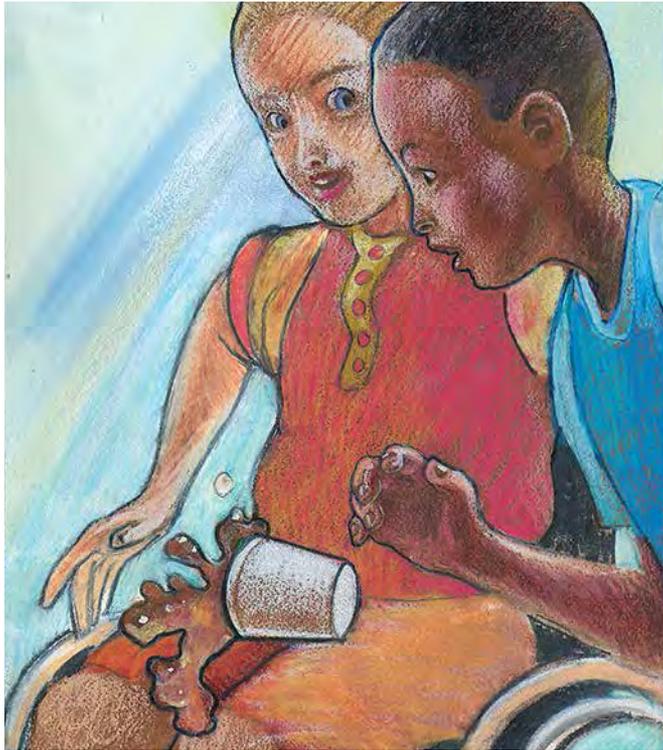
“Shiloh! Down!” Dr. Nimbus hit the gas and skidded into a tight turn, hurling a shower of gravel on the poachers. Shiloh heard a loud bang. It sounded like a tire blowing out, but the jeep sped away frantically.



From behind, the ground shook and a rumbling thunder seemed to rise from the acacia scrub. Shiloh turned, her body jerking wildly as the jeep jumped over mounds and crashed through the brush. What she saw, as she twisted in her seat, made her heart jump. Breaking down the vegetation in a mad, frantic, roaring charge were the rhinos—over twelve thousand pounds of terrified animal fury!

## Knee Jerk Reaction

B.J. hated the thought of gunshots, and the only rhinos she had seen were standing quietly at the zoo. As the story grew more exciting, she became more and more tense and began tapping her drumsticks wildly on the edge of Isley I's stool. Tap-tappity-tap-tap . . . She missed the stool and hit his knee instead. Pow! Isley I's lower leg snapped upward, kicking Max on the elbow.



As Max's arm flew up, his drink spilled on Shiloh.

"What's your problem?!"

Kyle yelled at Max. He tossed a towel to Shiloh.

"It appears as though we have a causal chain of events precipitated by an involuntary reaction, the patellar reflex," The Brain stated.

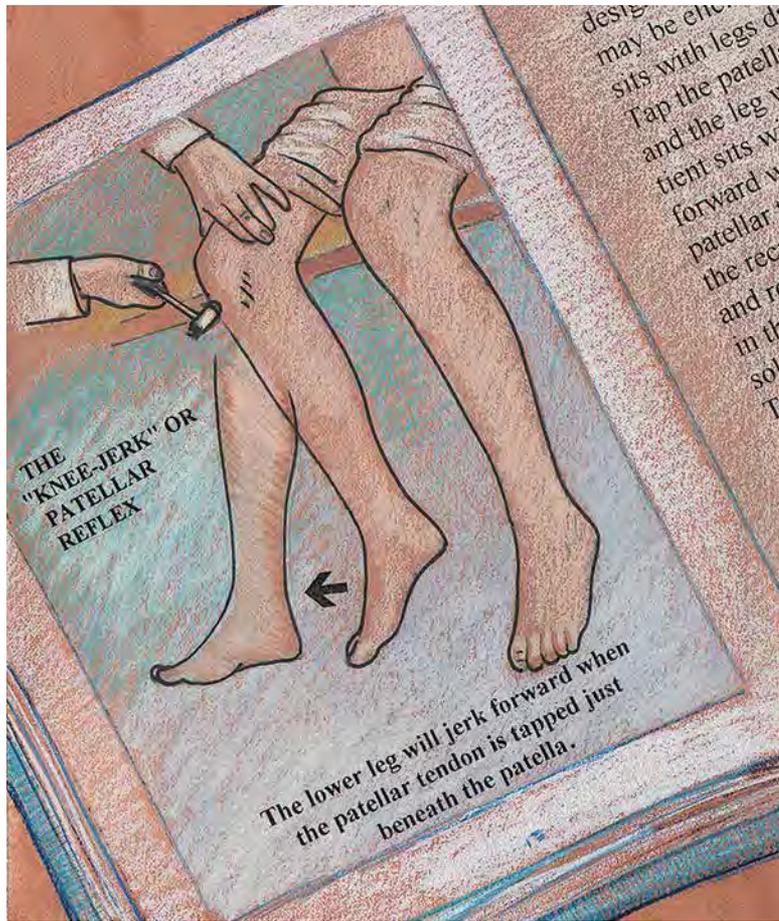
"The Brain's right," Max said. "That was some chain reaction!"

"I just hit Isley I on the knee by accident," B.J. added.

"Exactly," said The Brain, "and he exhibited the classic knee-jerk reflex. It's just the

same as when the doctor taps your knee, and your leg jumps up involuntarily. This involuntary movement is a reflex. With voluntary movement, the impulse comes from the brain, but reflexes can happen much faster, because the brain isn't involved at first."

"Wait a minute!" Isley II yelled. Everyone looked at him.



"He's confused," said Isley I.

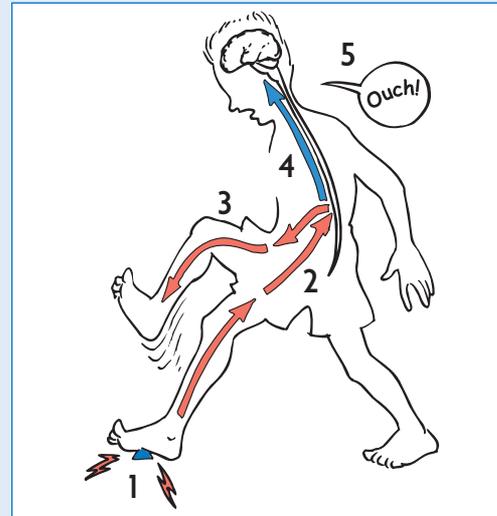
"And I suppose you understand all that?" Isley II shot back.

"Sure I do," said Isley I. "Just watch." He reached out and picked up a soda glass. "I want to pick this up. That's voluntary. I thought about it, and my brain sent signals through my spinal cord and out the nerves to my muscles, and I picked up the glass. Voluntary."

"But this," said Isley I, "is involuntary

Reflexes happen in the twinkling of an eye, within fractions of seconds! How can we react so quickly?

Reflexes follow simple pathways. For example, if you step on a piece of glass, a reflex response is triggered in your leg. Immediately, sensory neurons in your foot send a signal to motor neurons in your spinal cord. In a flash, motor neurons carry messages to muscles, so that your foot lifts itself out of danger and you keep your balance. Only later does your brain receive a message through the spinal cord, letting it know what happened. That's why you feel the pain after you have jumped away, and then you say "Ouch!"



movement,” and, without any warning, he struck Isley II’s knee with the side of his hand. Isley II’s leg immediately kicked out into the air.

“Hey, cut that out!” cried Isley II.

“See? That’s your knee-jerk reflex! You had no control over it,” his brother said.

“Why?” asked Isley II.

“That’s what The Brain just told us,” said Kyle. “Because reflexes don’t involve the thinking part of the brain. That’s why they can happen so fast.”

“Right,” Shiloh said. She understood all along. Now her mind dashed back to that fateful day in Africa.

Involuntary movements happen without our having to think about them. Some involuntary movements controlled by the brainstem, such as breathing and digesting, help our bodies to function properly. Reflexes also are involuntary movements, because we don't have to think about them.



Voluntary movements happen only when you want them to. They may be things you have never done before or movements you carry out every day, like walking or playing a sport. Voluntary movements improve when you practice them.

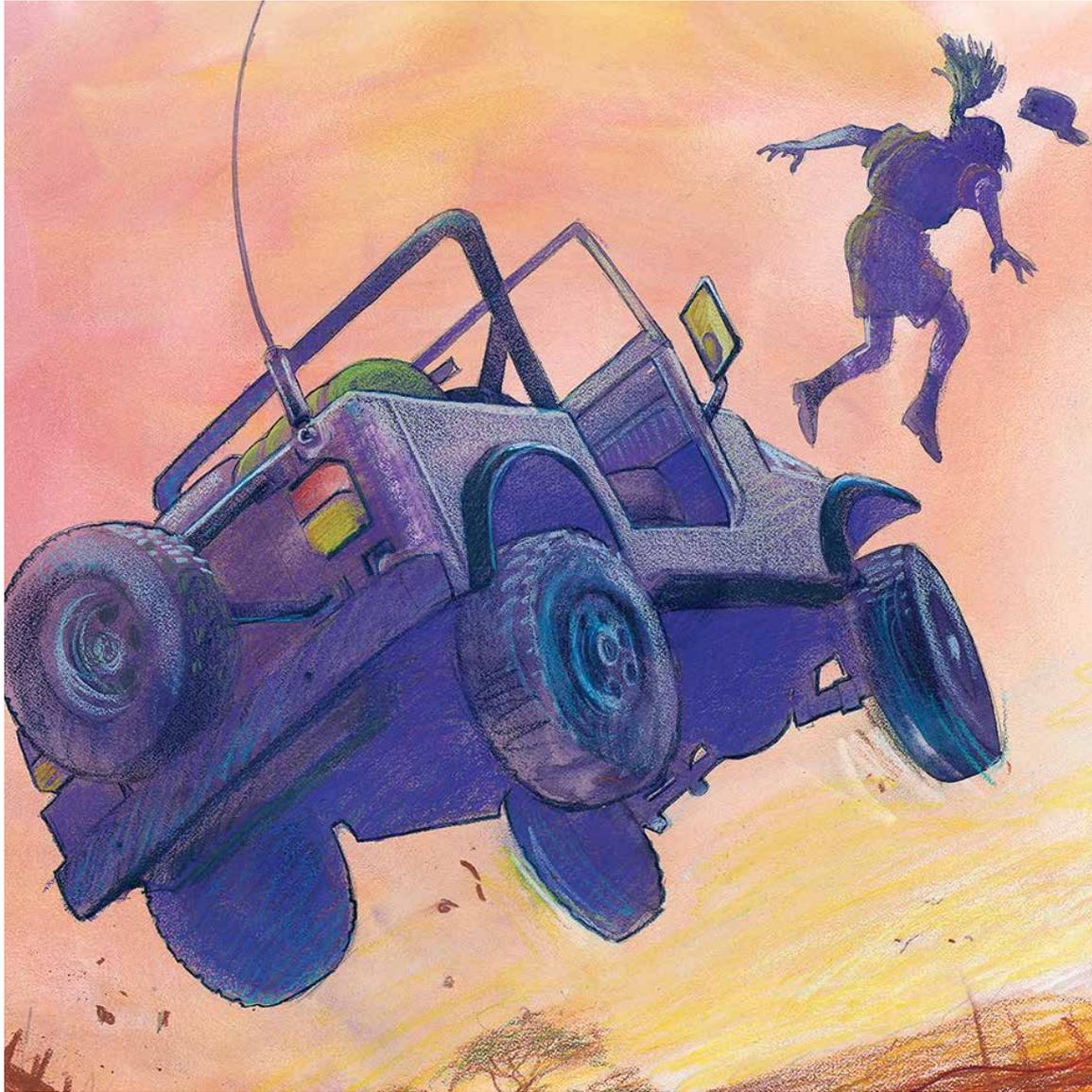
## An Unexpected Flight

Shiloh remembered it so well! Spinning, almost out of control, her father had battled the steering wheel. The thunder of the charging beasts seemed right behind them. More poachers could be anywhere—hidden, armed and waiting.

Suddenly, as they reached the top of a small ridge, a ravine appeared in front of them. Could they get around it? There was no time to stop and turn. There was no choice! From that moment on, everything seemed to happen instantly. There was no time to think or act. The jeep had to jump the ravine as they reached the crest.

Shiloh held on. She put her head down, and she saw her lap. No seat belt. She hadn't put it on. The jeep

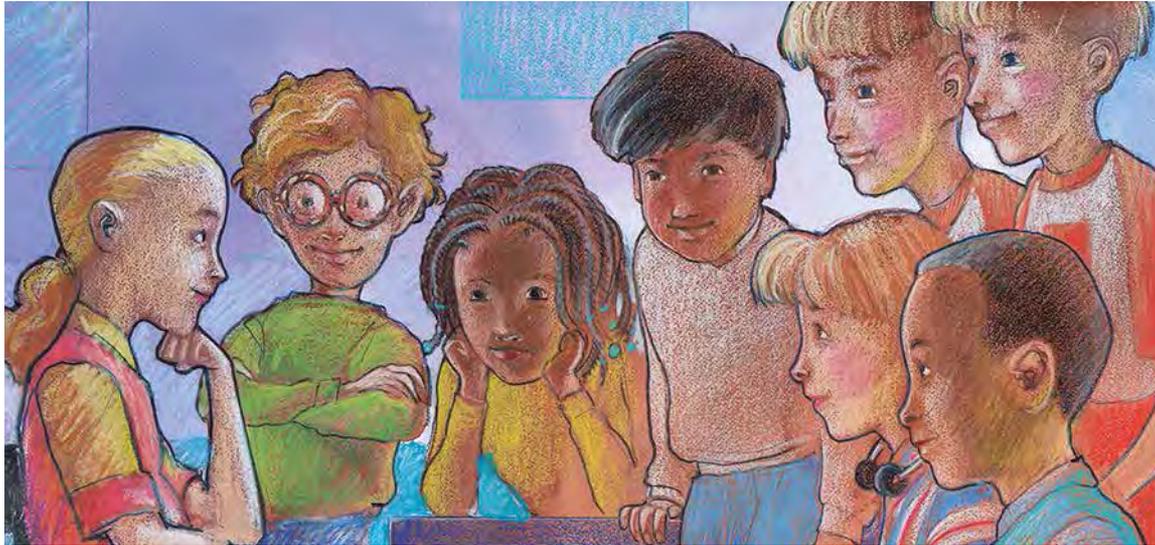
was in the air. Soaring, flying, scaling the Tsavo sky, wheels spinning madly on air, the jeep flew above the ravine. Shiloh's fear of the poachers and the animals disappeared. Suddenly she felt she was rising, going higher, thrown



Trouble at Tsavo  
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upward to the sun by a powerful force. Then she landed on the ground with a sickening thud.

Just then, a deeper sound of thunder arose. It was a chopping sound, accompanied by a dusty, intense wind. In her last second of consciousness, Shiloh saw a helicopter. *The rangers!* They had received her call.



## New Beginnings

The NeuroExplorers were silent. They felt exhausted—as if they’d actually been with Shiloh—fleeing from poachers and stampeding rhinos and arriving with her at the same final, painful escape.

“I woke up the next day in a hospital in Nairobi,” Shiloh said. “The doctors there were great, and they used all the newest treatments for spinal

injury. The steroids and emergency surgery to release the pressure on my spinal cord probably kept the damage from being even worse.”

“What a terrible experience!” Lakeisha said, shaking her head.

“It was very scary, and I guess I was really bummed out for a while,” Shiloh replied, “but I got really good care. I had six months in a rehabilitation center, and I’m learning how to live with my injury. I can’t walk, but I can get around just fine anyway. I can’t do gymnastics any more, but tennis sure is fun—and I’m going to learn karate soon. I’m really looking forward to going back to Kenya this summer, too!”

“Going *back*?” Kyle exclaimed.

“Dad’s going to capture a pair of black rhinos from the Tsavo park,” Shiloh explained. “The Kenyan government wants to start a new population in a more protected environment.”

The NeuroExplorers just looked on in admiration. They had learned a lot from Shiloh Nimbus—a lot that they would never forget.

Even ten years ago, scientists did not think that it ever would be possible to repair a damaged spinal cord. Now, researchers believe that new advances may someday help damaged nerves to regrow partially or may allow messages to be sent around areas that have been injured.



## Glossary

**acacia** (uh-KAY-shuh) - a spiny tropical tree belonging to the pea family; it produces large bean-like fruits or pods

**Alzheimer's disease** (ALLZ-hy-merz diz-eez) - a disease, found most often in older adults, that destroys cells of the central nervous system so that people can no longer remember or think properly

**anatomy** (uh-NA-tuh-mee) - the structure (both inside and outside) of a person, plant or animal

**archaeologist** (ar-kee-AHL-uh-jist) - a scientist who studies the remains of past human life

**black rhinoceros** (ry-NOS-er-us) - a large, powerful, scrub-tree-eating mammal of Africa, having a thick gray skin and two horns on its snout

**brain** (BRAYN) - the control center of the central nervous system, located within the skull and attached to the spinal cord; the command center of the body

**carcass** (KAR-kus) - the dead body of an animal

**cell** (SEL) - a tiny, basic structural and functional unit of which all living things are made

**cerebrum** (suh-REE-brum) - the large, rounded outer layer of the brain where voluntary movement is started, sensory input is received, and thinking and learning occur

**cortex** (KOR-tex) - the outer layer of the cerebrum

**cranium** (KRAY-nee-um) - the bones of the head except for the jaw bone

**Darwin, Charles** (DAR-win) - a naturalist in the 1800s who studied plants and animals around the world and is known for his book, *On the Origin of Species*

**epilepsy** (EH-pih-lep-see) - a condition brought about by sudden changes in the brain that affect a person's awareness and actions, often with jerking movements of the body and limbs, for short periods of time

**exotic** (eg-ZAHT-ik) - belonging to or living in another part of the world

**extinct** (ek-STINKT) - no longer existing

**extinction** (ek-STINK-shun) - the condition of being extinct or the process of becoming extinct

**fiber** (FY-ber) - a thread or threadlike part

**fracture** (FRAK-cher) - a break, especially of a bone

**impulse** (IM-puhls) - the transmission of a signal through a neuron fiber

**inflammation** (in-fla-MAY-shun) - a red and painful swelling caused by injury or infection

**involuntary** (in-VAHL-un-tair-ee) - not voluntary; happening without thought or control

**motor cortex** (MO-ter KOR-tex) - the region of the cerebrum responsible for starting and controlling voluntary movement

**motor neuron** (MO-ter NU-rahn) - a type of nervous system cell, originating in the brain or the spinal cord, that sends impulses causing movement

**nerve** (NERV) - bundle of neuron fibers

**nervous system** (NER-vus sis-tum) - the brain, spinal cord and network of neurons in the body

**neurologist** (nu-RAHL-uh-jist) - a medical doctor specializing in the diagnosis and treatment of disease and injury in the nervous system

**neurology** (nu-RAHL-uh-gee) - a branch of medical science which deals with the nervous system

**neuron** (NU-rahn) - a cell of the nervous system that conducts a signal from one part of the body to another; nerve cell

**neuroradiologist** (nu-ro-ray-dee-AHL-uh-jist) - a medical doctor who uses pictures of the inside of the body (X-rays and others) to identify injury and disease in the nervous system

**neuroscience** (nu-ro-SY-ens) - a branch of science related to the study of the nervous system

**neurosurgeon** (nu-ro-SUR-jun) - a medical doctor who specializes in operating on the brain, spinal cord and nerves

**neurosurgical nurse** (nu-ro-SUR-ji-kul NURS) - a nurse who is part of the team of people who perform surgery on the nervous system with a neurosurgeon

**paralysis** (puh-RAL-uh-sis) - loss of the ability to move

**paraplegia** (pair-uh-PLÉE-juh) - partial or complete inability to move the lower half of the body; usually the loss of use of both legs resulting from spinal cord injury

**patella** (puh-TEL-uh) - kneecap bone

**patellar tendon** (puh-TEL-er TEN-dun) - a fibrous band connecting the kneecap bone (patella) with the large bone of the lower leg (tibia)

**physician** (fih-ZIH-shun) - a medical doctor

**quadriplegia** (kwah-drih-PLÉE-juh) - partial or complete paralysis of the body below the neck; usually the loss of use of both arms and both legs resulting from spinal cord injury

**reflex** (REE-fleks) - an involuntary motor response to a sensory stimulus, usually for the purpose of protection; a movement that happens automatically in response to danger, a sudden noise or other stimulant

**rehabilitation** (ree-huh-bil-uh-TA-shun) - the process of restoring a person to a condition of health or restoring the ability to function

**sensory cortex** (SENS-uh-ree KOR-teks) - a portion of the cerebral cortex responsible for processing information from a particular sense (sight, smell, etc.)

**skeletal** (SKEL-uh-tuhl) - belonging to the framework of bones that supports the body

**skull** (SKUL) - all the bones of the head, including the cranium and the facial bones

**spinal cord** (SPY-nuhl kord) - the thin rope of nervous tissue inside the bones of the spine

**spine** (SPYN) - a series of connected bones along the back of a skeleton, also known as the backbone (spinal column)

**steroids** (STAIR-oydz) - biological compounds used in the treatment of many medical conditions, including swelling and inflammation

**tendon** (TEN-dun) - a tough band of tissue that connects a muscle to a bone

**terrain** (tuh-RAIN) - an area of land; the physical features of the land

**tissue** (TIH-shoo) - many cells of the same kind, joined together to do a specific job

**tracking** (TRAK-ing) - following tracks or a trail, especially in order to find an animal

**vegetation** (vej-uh-TAY-shun) - plant life of a particular region

**voluntary** (VAHL-un-tair-ee) - done on purpose or by choice

**white rhinoceros** (ry-NOS-er-us) - a large, powerful, grass-eating mammal of Africa, having a thick gray skin and two horns on its snout

**zoologist** (zo-AHL-uh-jist) - a scientist who studies animals

## About the Authors and Illustrator

**Grace Boyle, M.S.**, lead author, was a teacher in Hempstead, New York for 20 years and received her degree in Elementary Administration from Hofstra University. She developed, coordinated and implemented a program for gifted and talented students in the Hempstead school system. Ms. Boyle has written curriculum materials for several textbook publishers, specializing in activity books that encourage children’s critical thinking skills and stories that promote scientific curiosity. Currently, Ms. Boyle is a freelance writer. Her son, Dr. Thomas P. Boyle, a Florida radiologist, serves as consultant for her science-based writing.

**Judith Dresden, M.S.**, originally from New York and New England, formerly conducted educational research and evaluation for public and private schools, specializing in language arts. Editorial work with a publishing company also led to her interest in writing and editing stories and science activities for young students. As a BCM faculty member, she served as director of the BrainLink project, which brings the complex concepts of neuroscience within the grasp of children. Other activities involved promoting minority student access to careers in science and the health sciences.

**Barbara Tharp, M.S.**, originally from California and Oklahoma, once worked for the FBI in Washington, D.C., and later was an economic analyst for an oil company. More recently, she has followed her primary interest of working with children, serving as an elementary school teacher and specializing in her favorite subjects, science and math. Currently, she serves as a full-time faculty member at BCM. In addition to creating instructional materials, she directs science and math teacher enhancement programs with classroom teachers from Houston and throughout the U.S.

**Nancy Moreno, Ph.D.**, originally from Wisconsin and Michigan, is a biologist with a specialization in botany. She studied and classified neotropical plants in Mexico before completing her doctoral degree. Her current interests focus on the involvement of scientists in the education of students and teachers. She designs curricula, conducts workshops for teachers on creative methods for teaching science and using technology, and is involved in science education at all levels.

**T Lewis**, the illustrator, was born in Texas but has traveled extensively, living in such exotic locales as Africa, Switzerland and Alaska. Currently living in a small town in the state of Washington, where he and his wife are raising their young son, he “commutes” from time to time to Houston. He holds a bachelor of fine arts degree and has been a teacher in Alaska, 200 miles above the Arctic Circle. During this time, he also created paintings that are included in a Smithsonian Institute collection of Alaskan art.

While his broad range of professional artwork has appeared in many formats, T Lewis is especially fond of creating illustrations for children. Recent books bearing his work are *The Forgotten Helper*, *Bedtime Rhymes from Around the World* and *Cinderella: The Untold Story*. He has drawn the “Mickey Mouse” comic strip for Disney Productions and co-authors the comic, “Over the Hedge,” which appears in newspapers daily through United Feature Syndicate.





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