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ABSTRACT

The BrainLink project offers educational materials focusing on current neuroscience issues with the goal of promoting a deeper understanding of how the nervous system works and why the brain makes each individual special while conveying the excitement of "doing science" among upper elementary and middle school students. Project materials engage students and their families in neuroscience issues as they learn fundamental physical and neuroscience concepts and acquire problem-solving and decision making skills. Each BrainLink unit targets a major neuroscience topic and consists of a colorful science Adventures storybook, a comprehensive Teacher's Guide to hands-on activities in science and mathematics, a Reading Link language arts supplement, and a fun and informative Explorations mini-magazine for students to use with their families at home or in the classroom. This issue shows students how their brains store and retrieve information. (ASK)

Danger at Rocky River: A Memorable Misadventure.

BrainLink: Memory & Learning.

By Dane Chetkovich
Illustrated by T. Lewis
Revised by Barbara Tharp and Judith Dresden
Science notations by Nancy Moreno

BrainLink
MEMORY & LEARNING

DANGER at ROCKY RIVER

A MEMORABLE MISADVENTURE

THE NEURO EXPLORERS

Written by Dane Chetkovich
Illustrated by T Lewis

The **BrainLink®** series for health and science education provides:

- Adventures in learning: Story Books
- Exciting hands-on: Activities Guide for Teachers
- Engaging health/science mini-magazine: Explorations for Children and Adults

The **BrainLink** series includes:

Skullduggery
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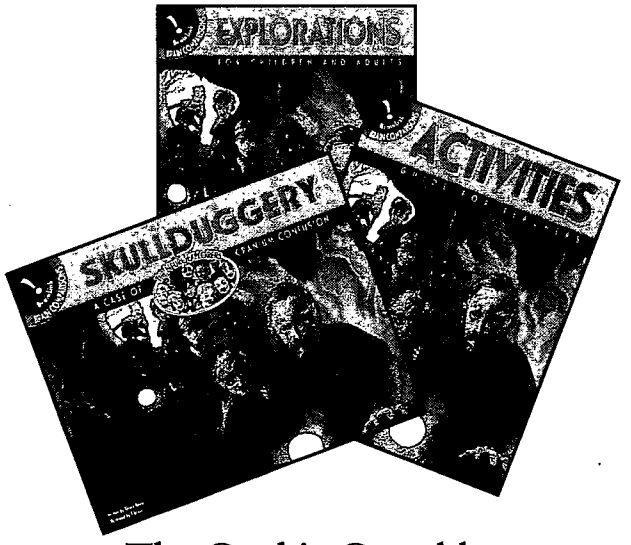

Trouble at Tsavo
Motor Highways

The Cookie Crumbles
Sensory Signals

Danger at Rocky River
Memory & Learning

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BrainLink® Adventures

DANGER AT ROCKY RIVER

The NeuroExplorers™ in A Memorable Misadventure

By
Dane Chetkovich
Illustrated By
T Lewis
Revised by Barbara Tharp, M.S. and Judith Dresden, M.S.
Science notations by Nancy Moreno, Ph.D.
Baylor College of Medicine

Houston

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For information, call 1-800-969-4996

Contents

The NeuroExplorers

The Beginning

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.

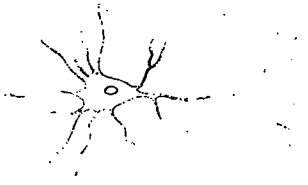
Some good came of Josh's unfortunate accident. For one thing, he learned never to ride without a helmet. Second, his misfortune was the beginning of the NeuroExplorers.

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 were medical specialists helping patients who had problems involving the brain or other parts of the nervous system.

It was Kyle Christian's idea to form the club. The members all 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 center for the rehabilitation of brain injury patients, held a Neuro-Science Fair 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 Club Members

Kyle Christian

Kyle'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 and play computer games. His hobby is memorizing fascinating trivia.

The Brain

When Antonio Velasquez-Ruíz, alias The Brain, 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.

Max Miller

Max has been friends with 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.

Lakeisha Crawford

Lakeisha 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. She also likes to play other games and sports. Karate lessons are her latest passion. Lakeisha has a little sister who has epilepsy.

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 from the notes of Charles Darwin.

B.J. Armstrong
B.J. 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 older 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've always called her B.J., and so do her friends.

Shiloh Numbus
Shiloh 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.

Josh Kavil
When Josh recovered from his head injuries, 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.

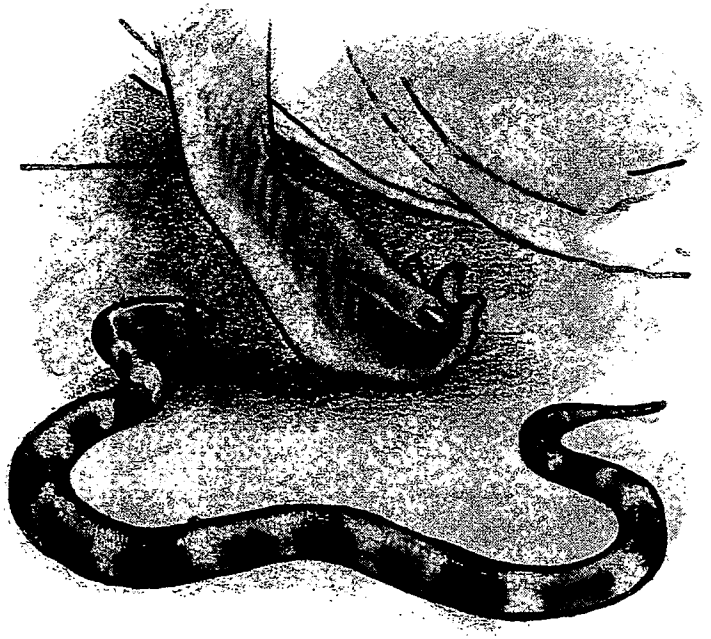
DANGER AT ROCKY RIVER

Red Then Yellow

The snake slithered and slinked its way across the floor. Isley I stared down in horror. He was terrified—paralyzed! For some reason, he could not use his voice. He tried to yell, but no shout, no gasp, not even the slightest sound would come out. The snake inched onward. All the while, Isley II slept on in the bunk bed below, his hand hanging out over the edge of the bed, inches from the floor. Yet Isley I could not make a sound to alert his sleeping twin brother. Surely the snake would not bite his brother's hand!

The snake hesitated for a moment. Isley I could now see the snake in great detail. It had stripes—red and yellow and black. It was only a few days ago that the twins learned about different kinds of snakes in science class. Now Isley I recalled a rhyme their teacher had taught them about snakes. It was a way to tell a poisonous coral snake from a non-poisonous striped snake by the pattern of its colored stripes, from head to tail—

Red then yellow,
Kill a fellow.
Red then black,
Friend of Jack.



The snake on the floor of the Isley twins' bedroom was clearly striped red, then yellow, then black—a poisonous coral snake! It was inches away from the sleeping Isley II's hand!

Suddenly, from somewhere in the distance, came a sound—"Beep-beep, beep-beep, beep-beep, beep-beep...." In an instant, the coral snake vanished and, for that matter, so did Isley II. The terrible dream was over.

Brain Power

The beeping alarm clock showed the time to be 9:30 a.m., as Isley I reached over and shut it off. The bright morning sun shone in through the open curtains. Now things were becoming clear to him. Yes, he had been dreaming. Thank goodness, he thought. He had to tell his best friends, the NeuroExplorers, about this dream. He climbed down off the bunk bed and noticed a note from Isley II taped to the door.

Good morning, Sleepzombie -
My turn to clean up the yard. NeuroExplorers Club meeting
at Kyle's house at 10:30. Don't be late.

At 10:30, all the NeuroExplorers except Shiloh, who was in Africa this summer with her father, were gathered around Isley I as he told them about his nightmare.

"You must have been really scared!" said Lakeisha.

The Brain looked thoughtful, then stated quietly, "This subconscious nocturnal adventure reveals a provocative lesson."

"Whaaat?" the others asked, all together.

Max Miller, as usual the only one who could understand The Brain without a dictionary, explained, "He said we could learn something interesting from Isley I's dream."

"Never sleep on the bottom bunk?" suggested Isley II.

"Actually, I was reflecting on the storage and retrieval of information," The Brain said.

"He was thinking about learning and memory," Max interpreted for the others.

"What do learning and memory have to do with a dream about a coral snake?" asked Josh. The room was quiet as they waited for the Brain's answer.

"Isley I," said The Brain, "do you recall the time you were distressed because you couldn't recall a list of things Max asked you to purchase for him at the hobby shop?"

"Yeah, I can never remember stuff like that. I'm not a good memorizer," Isley I said.

We are always learning. Every day, new information enters our brains and is stored in ways that let us find it and use it again. The storerooms in our brains hold information about people we have known, experiences we have had, emotions we have felt, and skills that we have mastered, including languages. These are our memories. There are many different ways of learning.

We learn by copying what we see or hear. This is learning by imitation.

We learn by making connections between experiences. This is learning by association.

We learn by repetition—doing something over and over.

"Yet you remembered quite graphically and quite correctly, I might add, that coral snakes are striped red then yellow," The Brain continued. "How did you do that?"

"Well, I'm not sure, really," Isley I said. "It was the rhyme, I guess. Red then yellow, kill a fellow...that means it's a poisonous coral snake. I like rhymes. I suppose that's what made it easier to learn."

"Your memory got better because of a rhyme?" Lakeisha asked.

"Rhythm and rhyme—they help all the time," B.J. rapped with her drumsticks on the table.

"Precisely my point," The Brain said. "A previously poor memorizer now benefits from the use of an ingenious device for the purpose of memory enhancement. It would behoove the NeuroExplorers to acquire more data regarding the nature of information storage and retrieval, which are, of course, significant and fascinating functions of the human brain."

Before anyone could ask, Max translated, "The Brain says there are ways to improve your memory, like Isley I did with the rhyme. He says that learning and memory are really

neat and important things the brain does, and it would be good for us to find out more about them."

"And for NeuroExplorers," Josh added, "understanding the brain is all in a day's work!"

Remembering An Old Friend

"It's settled then," Lakeisha said. "We'll learn about learning."

"And remembering," Kyle added. "I love to be able to remember all kinds of trivia that nobody else knows."

"Yeah, like all the baseball players' records," added the Isleys, almost at the same time.

"Who should we ask to help us learn about learning and remembering?" Josh asked.

"How about a scientist?" suggested Kyle.

"Hey, why not Professor Ottzinger from the university?" said B.J. "We haven't seen him since he took us to the Skull Caves, and besides, he said we could come to his office anytime we wanted. How about now?"

In a flash, Kyle ran up the stairs, shouting back to his friends, "I'll call and see if he's there."

In a few minutes, Kyle came back and announced, "He says to come on over right now. He'll wait for us. Let's go!"

The NeuroExplorers picked up their helmets and piled out of the house. Soon they were pedaling their bikes toward Dargate University. They rode through the gate and up to the ivy-covered old building where Professor Ottzinger had his office.

Tricks of the Memory

Professor Ottzinger listened closely, stroking the head of the dog sleeping at his feet, as Isley I finished telling about his dream of the night before.

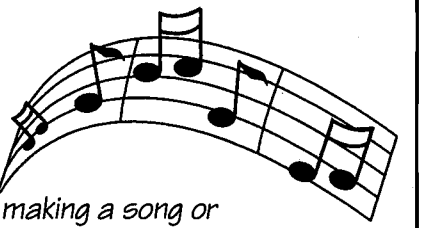
"Frightening!" the professor said with a shudder. "I certainly wouldn't want a poisonous coral snake in *my* bedroom! But tell me—you said on the phone that you wanted to know more about learning and memory."

"Yes, it's because of Isley I's dream," Max said, looking toward his friend.

"I usually have trouble memorizing stuff," Isley I explained, "but I remembered the color pattern of coral snakes right away, even in my dream. The Brain thought that the rhyme our teacher taught us helped me to remember."

Memories of what we have learned about people, events and facts of the world are processed in the cerebrum. By thinking about them, we can recall these stored memories.

We can boost our abilities to remember things. Try making a song or poem that includes the things you are learning.

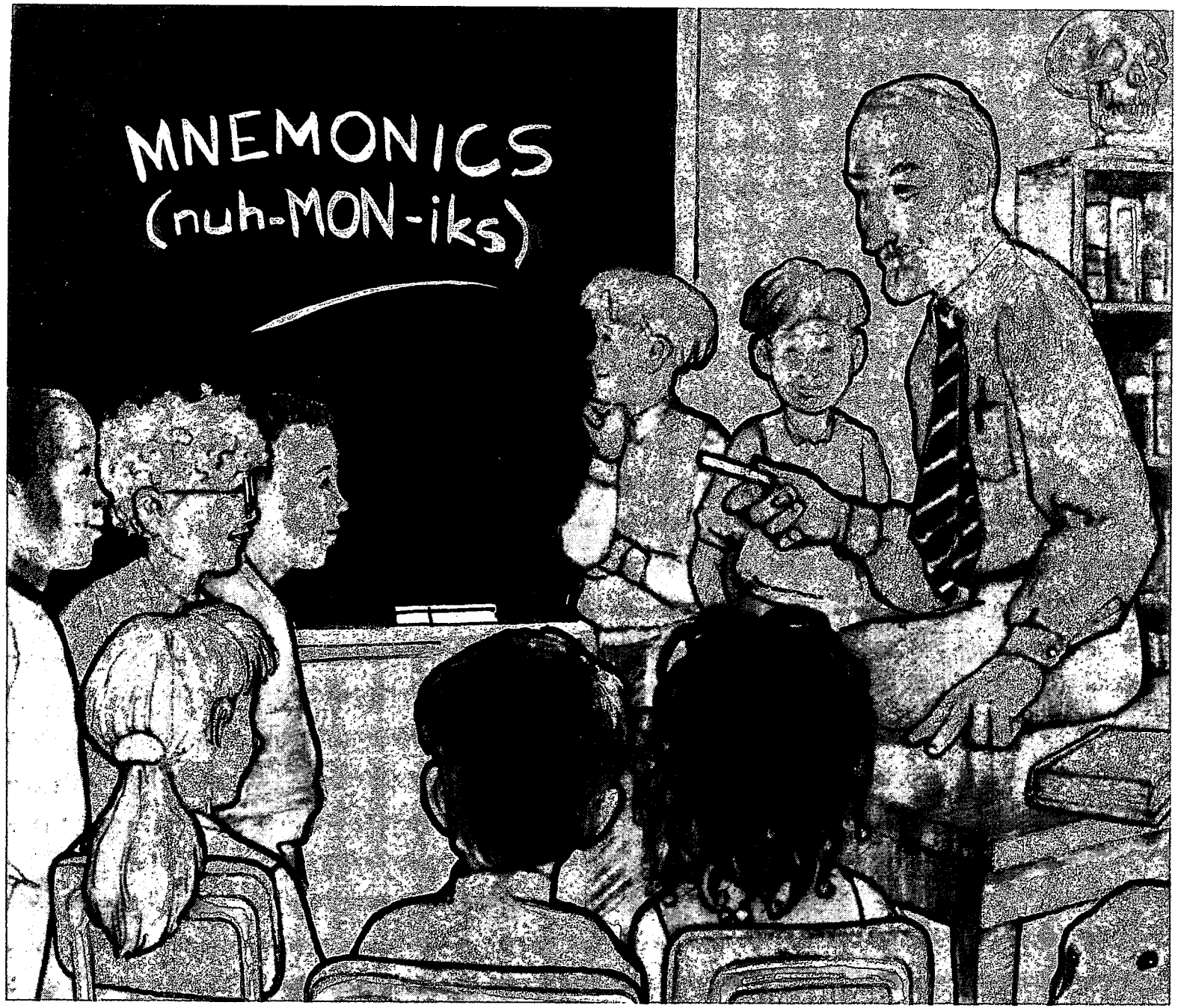


Or create a word or phrase from the first letters of the names of the things you want to remember. You even can create a picture in your mind to help you remember a difficult word or concept.

"You NeuroExplorers never cease to amaze me!" said the professor. "That's exactly right. It's much easier to learn and remember something if you can associate what you're trying to remember with a picture, or put the facts into a rhyme."

"Or how about making a word from the first letters of all the words in a list?" Josh said. "Did you ever hear of ROY G. BIV? It stands for red, orange, yellow, green, blue, indigo, violet—the colors in a rainbow. Just remembering the name is a lot easier than trying to remember all the colors in the right order."

"Exactly!" agreed the professor. "All of these tricks, or ways to improve memory, are known as *mnemonics*." He got up and wrote the word on the blackboard. "It looks funny, but you say it like this—nuh-MON-iks." Then



Several areas of the brain are important for processing memories. Memories of what we have experienced or learned are processed through the hippocampus. This group of neurons, deep inside the brain, is shaped somewhat like a sea horse. Each person has two hippocampi (plural of hippocampus), one in each half of the brain. When the hippocampi are diseased or damaged, it is not always possible to learn new things and remember them.

everybody said it. It was a pretty strange word.

"I like to make up rhymes with drum rhythms," said B.J. "Sometimes I use them to help me remember things."

"Great idea!" agreed the professor.

Lakeisha spoke up. "So if I wanted a 'nuh-MON-ik'," she said slowly, "to remember a grocery list of bread, rice, apples, ice cream, and napkins, I could use the word, BRAIN."

"NeuroExplorers learn fast!" said the professor. "Did you know you're using your hippocampi?"

"Hippo *whose* eye?" asked Kyle.

"Hippocampi," the professor repeated. "The hippocampus is a part of the brain that is very important for learning and memory," he explained as he wrote and said the word slowly—"hip-uh-KAM-puhs."

The NeuroExplorers looked at each other. Josh scratched his head, and everyone but The Brain looked very puzzled.

The Hippo Takes a Dive

Professor Ottzinger pulled a book from his shelf, opened it and pointed to a drawing of the brain. "Here's a picture that shows the hippocampus. It's deep inside the temporal lobe of the brain. We'd have a hard time remembering anything if we didn't have our hippocampi. Do you think you can remember that word?" he added.

"I bet *I* can!" said Isley I. "I can picture a big fat hippo jumping off a diving board at summer camp, remembering at the last minute that he forgot to take off his hat!"

Isley II laughed and poked his brother in the ribs.

"What?" asked Josh, twisting his face in confusion.

"Hippo—camp! That reminds me of hippocampus. And the hippo's remembering something. That helps *me* to remember that the hippocampus is a part of the brain used for memory. It's a mnemonic!" Isley I said with a proud smile.

"Excellent!" exclaimed the Professor.

B.J. began to tap her

drumsticks in rhythm as she made up a rhyme—

"Hippo camp, just think of that.
A hippo's diving with his hat!
The hippocampi in my brain
Let me remember this refrain."

Suddenly the NeuroExplorers heard a low growl. A large, furry object sprang to life from across the room. "Oh no!" exclaimed the Professor, "I forgot...."

The angry animal bolted toward them, fierce eyes burning like fire, fangs bared in a primitive growl that sent shivers up their spines. The dog was headed directly for B.J.!

"B.J., drop the drumsticks—now!" yelled the professor.

The dog leapt into the air as B.J. dropped her sticks, frozen in terror.

Good Dog With A Bad Memory

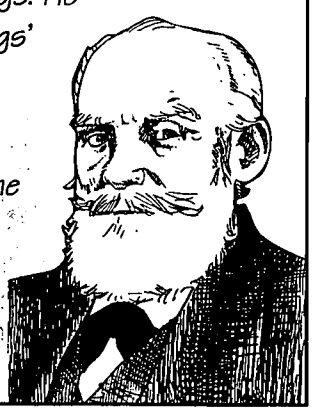
It all happened so fast. The big dog landed at B.J.'s feet, scooped up the drumsticks, and ran from the room. The NeuroExplorers let out a big sigh of relief.

"Whew!" exclaimed Professor Ottzinger. "I apologize for Pavlov! Before I got him from the pound, someone had beaten him with a stick, and he still remembers it," he explained. "To this day, sticks make him crazy. He'll try to take them away from anyone. He wouldn't have bitten you, but I know it was pretty scary there for a few seconds. I'm terribly sorry."

"I'll say it was scary!" said B.J. "I thought he was going for my throat."

Ivan Pavlov, a famous Russian scientist, studied digestion in dogs. He observed that the mere sight of food would make dogs' mouths water. As an experiment, he tried ringing a bell every time he fed the dogs. He found that, after a few times, the dogs' mouths would water when they heard the bell, even without seeing the food.

The dogs had learned to associate the ringing of the bell with being fed! This famous experiment was the first demonstration of "classical conditioning."



The NeuroExplorers' hearts were still racing, when Pavlov trotted back into the professor's office. He certainly seemed less menacing now. He was the same friendly dog he had been before the attack. He laid down at the professor's feet, and B.J. walked cautiously toward him. "Poor guy," she said, "I guess I frightened you, too." Pavlov wagged his tail. The terrible moment was over.

Memories associated with disagreeable experiences often are very strong. Blue jays, for example, learn to avoid Monarch butterflies after trying to eat just one. Monarch butterflies taste extremely bad. After the first experience, a jay will never try to eat a Monarch butterfly, or anything that even looks like one, ever again!

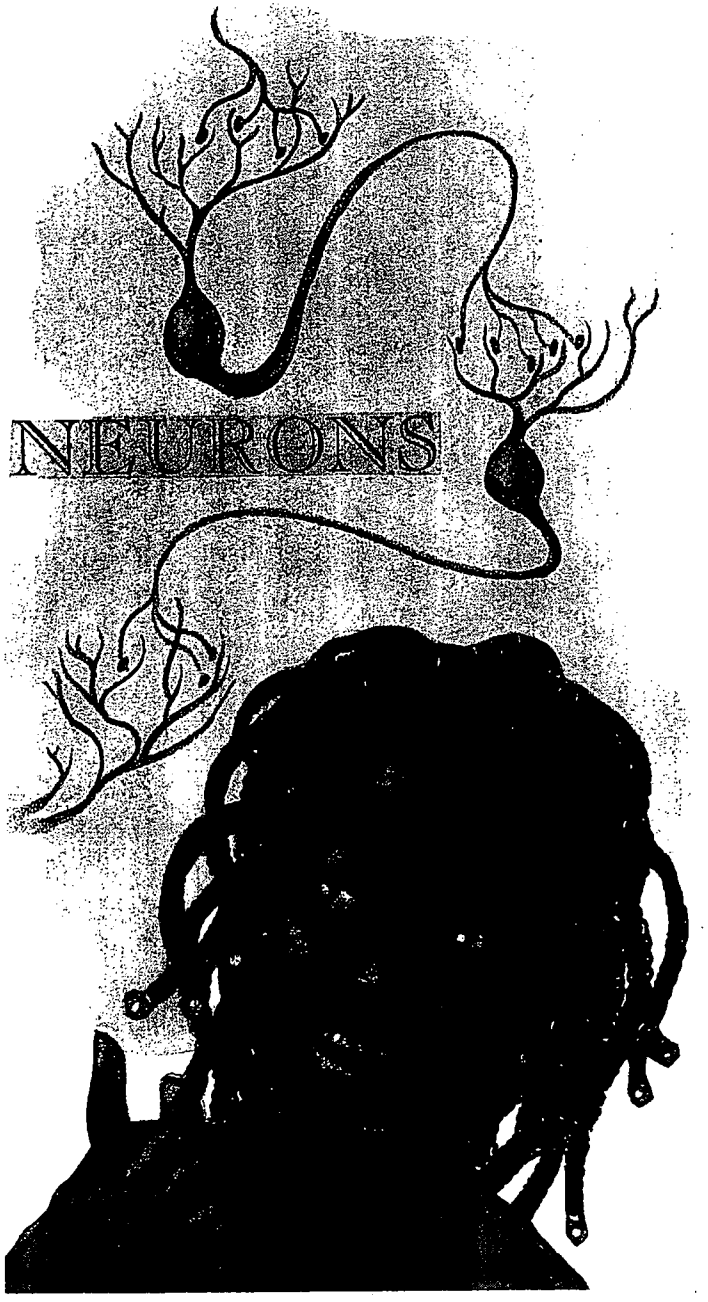
How Are Your Hippocampi?

"Do dogs have hippocampi?" asked Josh.

"Yes, they do," said the Professor. All mammals have hippocampi. Just like in humans, dogs' hippocampi are important to help them learn and remember things."

"How about neurons?" Lakeisha asked. "Like in the motor system and the sensory system, do neurons send messages for remembering?"

"Absolutely right," Professor Ottzinger replied. "There is a whole network of neurons in the hippocampus and other parts of the brain



that are used for memory. Good thinking, to remember the neurons!" he complimented Lakeisha.

The Brain added, "Lakeisha's proficiency in information storage and retrieval demonstrates the efficiency of neuronal activity in her hippocampi."

The NeuroExplorers looked at Max. "Interpreter..." they groaned.

"The Brain says that because of the way Lakeisha learns and remembers things, her hippocampi must work really well!" Max said.

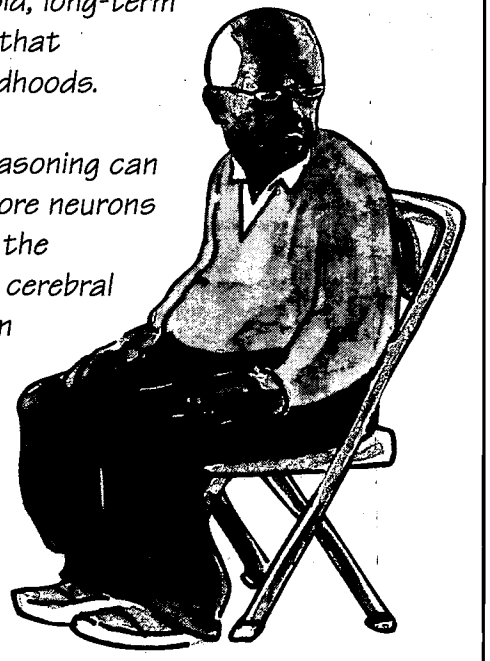
"Probably true," said the professor. "I'm sure you all have very healthy hippocampi! But, you know, there are some diseases that affect that part of the brain. They destroy neurons in the hippocampi, so that a person has trouble remembering things. That's what happens in Alzheimer's disease."

"What a funny name. Why is a disease called that?" asked Kyle.

"It's named after the person who discovered it," said Professor Ottzinger.

Alois Alzheimer, a German doctor and neuroscientist, described Alzheimer's disease, or A.D., in 1906. It usually affects older people, destroying neurons in their brains. At first, they might have trouble with their short-term memories—like what someone just told them—but not with old, long-term memories, like things that happened in their childhoods.

Later, memory and reasoning can get much worse as more neurons are damaged, both in the hippocampus and the cerebral cortex. Even long-term memories may become confused or lost, and A.D. patients may need constant help with their daily lives.



"I've heard of Alzheimer's," exclaimed B.J. "My brother told me about it, and I can remember the name by thinking, 'Alzheimer's—old-timers.' Only old people get Alzheimer's disease, right?"

"Usually, people your grandparents' ages or older get A.D.," the professor answered.

"It sounds terrible!" said Kyle.

"Our grandparents could get that disease!" Lakeisha added, with a shudder.

"Don't worry—most older people don't get Alzheimer's," said Professor Ottzinger. "While the memory normally tends to fade a little as we get older, about 15 percent of Americans over 65 actually have Alzheimer's disease."

"My Grandpa Miller has Alzheimer's disease," whispered Max. There was silence. You could have heard a pin drop.

Max's Fear

All eyes were on Max. No one knew what to say. Finally, The Brain broke the silence.

"I'm sorry, Max." No one needed to translate the Brain's kind words to his best friend, "Are you okay?"

"I'm okay," Max replied. "I'm worried about my Grandpa, though. The doctor told us he had Alzheimer's disease almost two years ago. It's just like the professor said—he started having trouble with his memory. He would go to the store, and then when he got there he would forget what he was looking for. That wasn't so bad, but once he went for a walk after dinner and he got lost. The police found him at midnight, walking in the middle of the road."

Everyone was listening quietly to Max's story. He continued, "After that, Grandpa went to live with my Uncle Ed in Crystal City. That worked out fine for a while, but just last month he had to move to a place where someone is there to help him all the time. Mom says it's nice there, and he likes it pretty well, but I'm afraid he must get lonesome without any of us around."

"Can't you visit him?" asked Lakeisha.

"Yes, I can," said Max quietly, staring down at the ground, "but..."

"So why don't you go see him?" asked Kyle.

There was a long pause. Max looked at his friends for a second and then quickly looked away and gazed out the window. His eyes filled with tears. "Because I'm scared that he won't remember who I am," Max said quietly.

He told his friends that, only a few years ago, his grandfather used to take Max fishing and hunting. He taught him about different kinds of fish and birds and plants. Now Max's Grandpa could not always remember where he was or what he was doing.

The Brain put his hand on Max's shoulder. "Why don't you go see him? We'll go with you," he said.

Max took a deep breath. He knew he was not alone. For that moment he was not so frightened of the terrible disease that was taking his grandfather away from him. "Okay," he said, "let's go today. Meet at Kyle's right after lunch."

A Warning

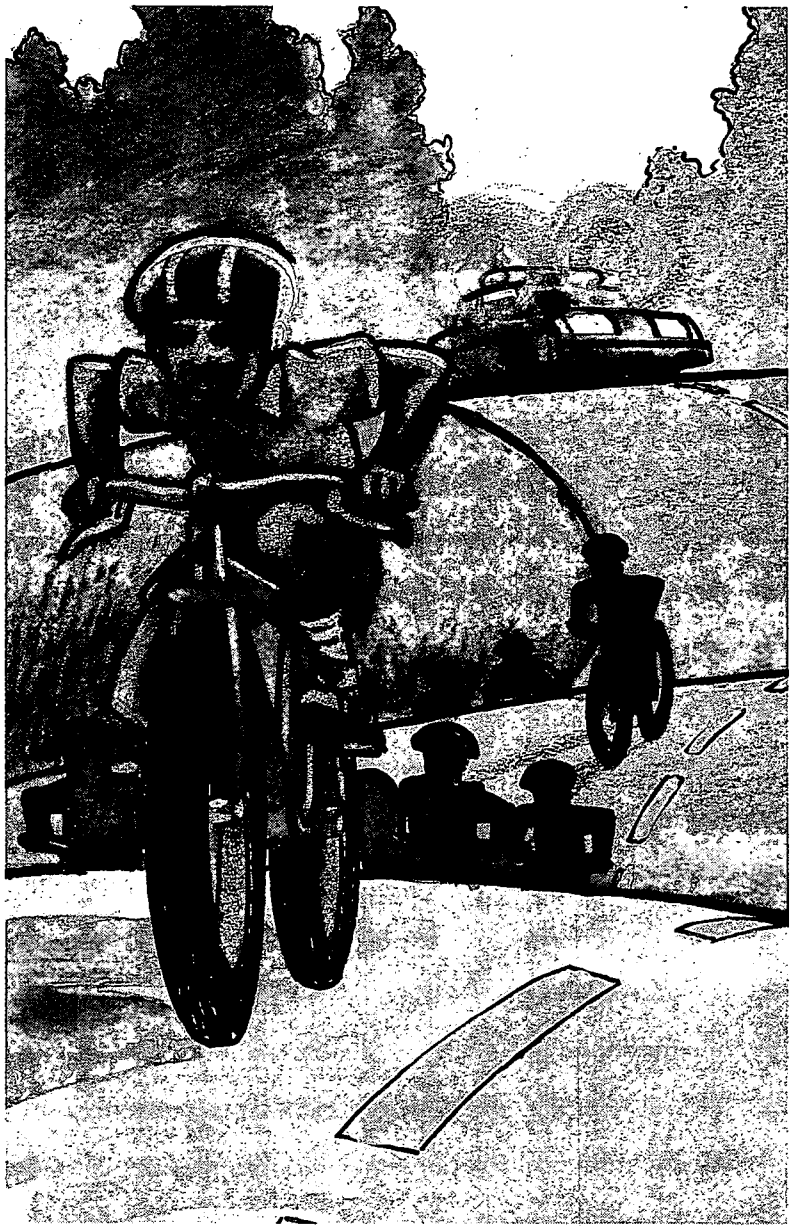
It was a good thirty minute bike ride out to Riverbend Gardens Retirement Center. Now that he had decided to visit his grandfather, Max was in a hurry. He was pedaling so fast, it was hard for the others to keep up with him.

"Hey, slow down," B.J. called, "—and move over. There's a car coming."

A car with flashing lights pulled up beside them. It was the county sheriff. He rolled down his window and asked, "Where are you kids going?"

"We're going to Riverbend Gardens," said Max, "to see my grandfather."

"Okay, the road is safe up to there," said the sheriff. "I'm going over to the river to close off the county road. It's been raining pretty heavy up north, and the water's getting high at some of the river crossings. Just stay out of the



lowlands. It may be dangerous around Rocky River." He sped up again and took off down the road.

"Isn't it funny," Josh thought aloud, "that he's talking about flooding when it's not even raining? The sun's shining."

"I remember a couple of years ago," Kyle said, "when it rained for days in the hills above the lake, north of here. They had to open the dam, and Rocky River got so high that it flooded into some houses, even though it never rained around here. I hope that doesn't happen again."

Games and Grandparents

The NeuroExplorers reached the retirement center, parked their bikes and walked up the flower-lined path to the lobby. A woman came to greet them. "Hello there!" she said cheerfully. I'm Ms. Garza, director of Riverbend Gardens. Are you here to visit one of our residents?"

"We're here to see my Grandpa, Isaac Miller," said Max.

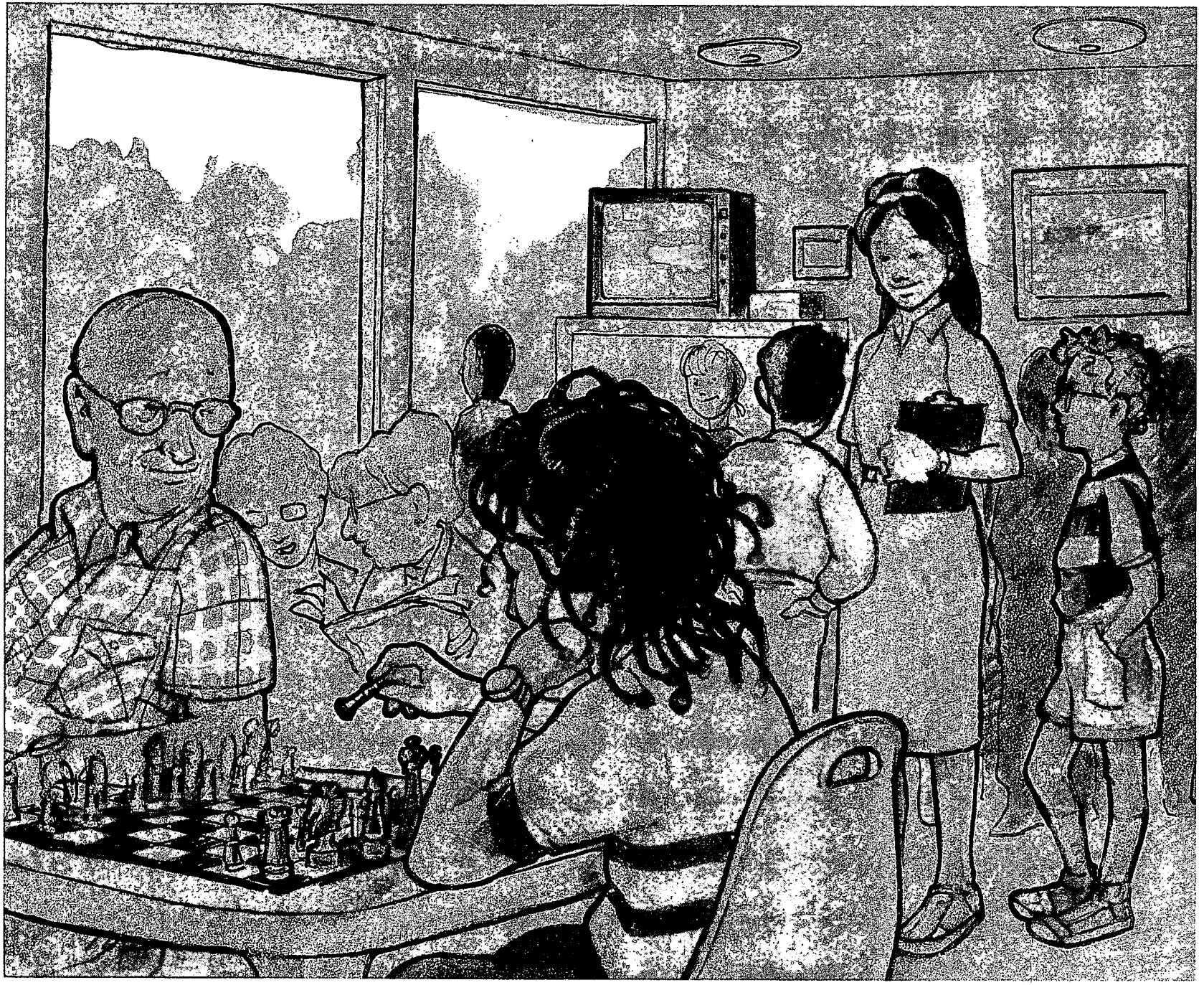
"Super!" exclaimed Ms. Garza. "Mr. Miller will be thrilled to have so many guests. I think he's taking his afternoon walk, but he should be back in a few minutes. Why don't you wait in the game room?"

"Games?" asked Isley II, a glimmer of excitement in his eyes.

"Follow me," said Ms. Garza.

They entered a brightly lit room. Two women with white hair were sitting in front of a big-screen TV playing a video game, and four or five other residents were sitting on the couch, cheering them on. Isley II immediately introduced himself and sat down by the ladies.

A man was sitting at a table in front of a chessboard. "Any of you kids ever play chess before?" the man asked.

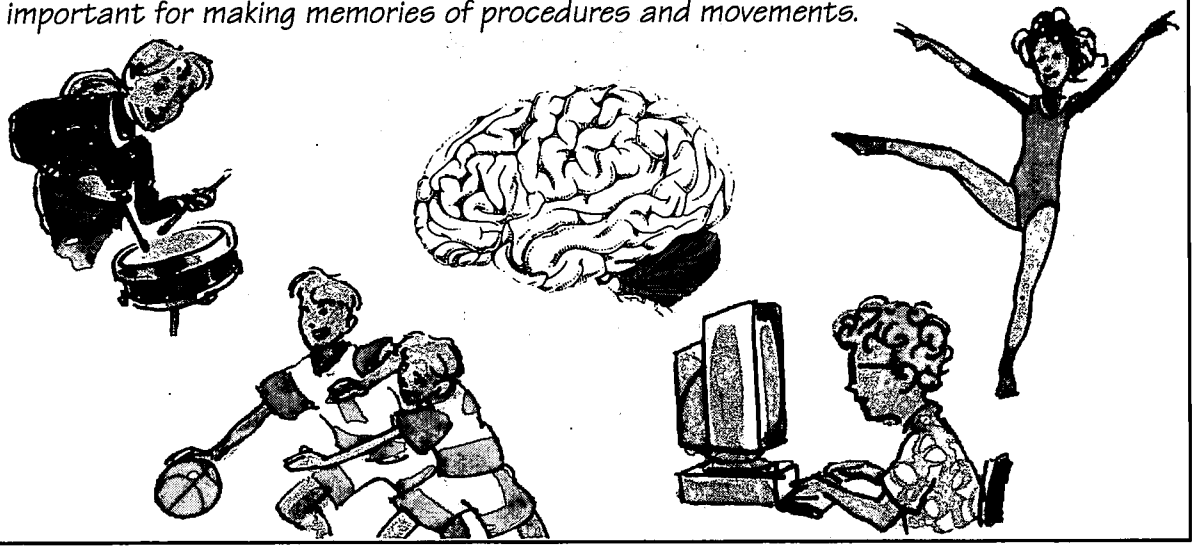


Lakeisha spoke up, "Well, I've played some chess." She turned and winked at the other NeuroExplorers. Lakeisha was good and she knew it. She sat down with the old man and introduced herself.

"Plotsky's the name," the old man said. "You can go first." After ten moves, Lakeisha's jaw nearly dropped to the floor. This man had strategies she had never seen. Lakeisha lost the game and quickly started setting up for another one. She could learn a lot from Mr. Plotsky.

Max was staring out the window, looking for his grandfather. Meanwhile, the other NeuroExplorers were talking to Ms. Garza. "It seems like everybody has a good time around here," Josh said.

Becoming skilled at playing a video game is an example of creating memories of how to do something. Memories of procedures and movements—like playing games or sports, walking, writing, dancing or playing a musical instrument—are stored in the cerebellum. Repetition, or learning by doing something over and over again, often is important for making memories of procedures and movements.



"Oh, yes," Ms. Garza agreed. "We have lots of activities and interesting things for the residents to do. Sometimes they do get lonesome, though. We really love to have visitors."

All of the residents in the game room did seem to be glad the NeuroExplorers were there. They kept each one busy talking, laughing and playing games.

I wish *my* grandfather lived here," said B.J. "Then I could come visit every weekend."

"You're welcome here, anytime you want," said Ms. Garza. "We'd love to have you visit!"

"Aaagh!" Lakeisha exclaimed to her chess partner. "You got me again. Another game?"

"But of course," said Mr. Plotsky. "This is great brain exercise! Use it or lose it, they say."

Just then a young man wearing a white jacket burst into the game room. "Ms. Garza, I need some help!" he said. He was out of breath. "I can't find Mr. Miller! I was taking him for a walk down by the woods near the river. I just ran back for two minutes to get a pair of binoculars for us to watch the birds, and he disappeared. He was sitting there, and he said he wouldn't move until I got back. But he's gone, and now the river's rising!"

A Raging River

"What? He can't be gone!" screamed Max. "He might not find his way back! We have to find him."

"Let's be calm about this," said Ms. Garza. "I'm sure he'll be okay. I'll send somebody out with Vince, and they'll find your grandfather—you'll see."

But for Max, it was too late for calm. He raced out the door and headed straight for the woods. The other NeuroExplorers were close behind. They were tearing along the path toward the river, when Max suddenly stopped. His friends all but piled into him.

"Hey, why did you...Wow!" said Josh as he looked ahead.

The Rocky River was raging wildly out of its banks. The NeuroExplorers could see the water rising before them. It was about to reach the footbridge that led across the river.

"Do you think your Grandpa crossed the river here?" Lakeisha called over the roar of the water.

"Here are some footprints, with marks made by a cane, leading right up to the bridge," said Max. "I'm going across. I have to find him."

"Are you nuts?" Lakeisha said. "It's too dangerous. Look at that water—it's flooding!"

"I've got to cross," Max repeated. His friends knew he was going, no matter what. There was no way to stop him.

"Not alone!" said The Brain. "I'm going with you."

"Me too!" said B.J.

"OK, let's go," the others chimed in, and they followed Max. The water now covered the bottom of the bridge. Their feet began to slip and slide. They had to hold on to the railing to pull themselves toward the other side.

Suddenly Max lost his grip. B.J. was right there, and she grabbed him by the shirt, just in time to stop him from being washed downriver.

Water Power

"He's over here. He crossed the river!" Max shouted as soon as he and B.J. reached the opposite bank and scrambled out of the water. "Here are his footprints!"

All the rest of the NeuroExplorers were right behind them, except for Isley II. He was still on the bridge. He could barely hold on. Suddenly, one side of the handrail broke off in front of him.

"My hands are slipping!" Isley II screamed to his friends. They could see the terror in his eyes.

"Hold on!" yelled Isley I, starting to go into the water after his brother. He was stopped by a long branch that floated between them. Quickly, he caught the branch and pushed it toward Isley II, shouting, "Grab this and I'll pull you out!"

The NeuroExplorers watched in horror. A log was floating rapidly toward Isley II. It knocked him away from the branch, and the current washed him downstream.

"Noooooo!!!" screamed Isley I, and he started to run along the edge of the rushing water. The others were right behind him. Vince, who hadn't made it across the bridge, joined the chase on the opposite bank. They all

ran as fast as they could, but they couldn't keep up with the flooding river. They saw Isley II's head in the water, and then they lost sight of him as he plunged through the rapids. They ran for what seemed like a mile before the rapids ended and the river slowed. Then they saw something floating near the shore. It was a high-top basketball shoe—one of Isley II's shoes! But Isley II was nowhere to be seen.

"We've lost him!" Isley I moaned, slumping to the ground. No one answered. They all stared blankly at the river.

Then through the bushes came a familiar voice. It was Isley II, soaked and coughing up some water, but safe! "You guys give up too soon," he spluttered.

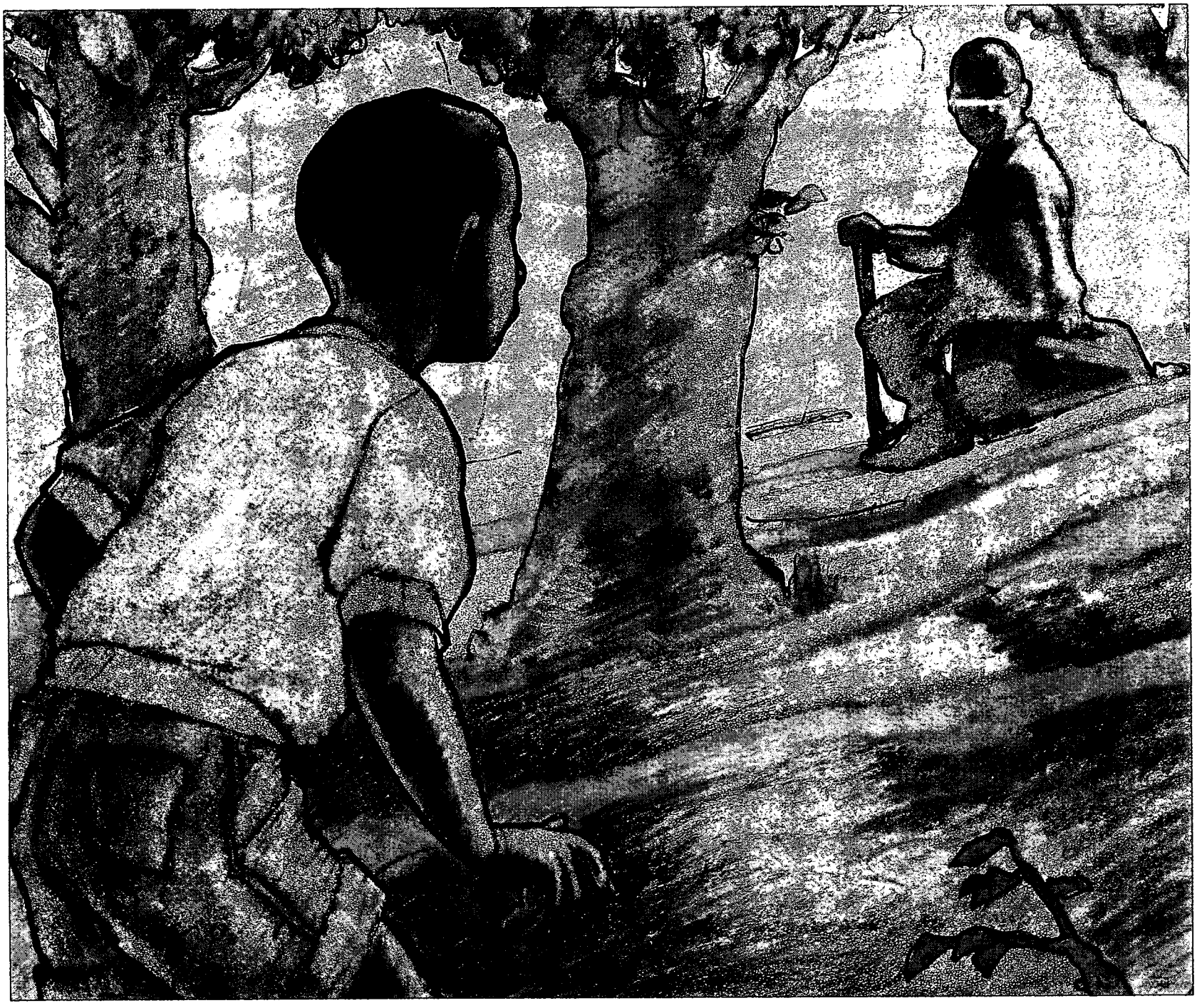
Isley I had never been so happy to see his brother. He ran over and gave him a big hug. Isley II was soaked, scratched up and out of breath, but he seemed okay.

"What a ride! Man, those are some rapids," Isley II said. "You guys ought to try it!"

"Those rapids must have rattled your brain! It's not exactly a safe sport right now," Isley I retorted. He grabbed his brother's arm and pulled him farther away from the wild river.

"Come on, let's get out of here," Kyle said. "Boy, I'm never going to forget this day!"

"We've still got to find my Grandpa," added Max, tossing Isley II his missing shoe.



Looking for Grandpa

Vince yelled from across the river that he would go back to the road and try to drive across downriver. He would come and pick them up.

The NeuroExplorers immediately began to look for footprints again. And soon they found them—marks made by a man with a cane—on the high ground above the water! They led into the woods away from the river.

Soon the soft ground ended and the footprints disappeared. "We've lost the prints," said Josh. Max kept walking.

"*Max*, we've lost the prints," Kyle echoed. "How will we find him without footprints?"

Max kept walking, silently. He seemed to sense something the others couldn't, as he followed a small path in the woods. Suddenly he stopped. There, sitting on a rock in the clearing, was his grandfather.

Max stood very still. He just stood there, without moving or saying a word. Finally, The Brain put his hand on Max's shoulder. "We're here for you, Max," he whispered.

As Max finally stepped slowly into the clearing, the man turned his head and looked at him. His grandfather's face gave no sign that he recognized the boy walking toward him. Max froze. It seemed like forever before anyone spoke.

Finally Max said softly, "Hi, Grandpa. It's me, Max."

The old man looked confused. All of a sudden he smiled and said, "Max! Come give your Grandpa a hug!" His voice was as warm as the afternoon sun behind him.

Confusing Questions

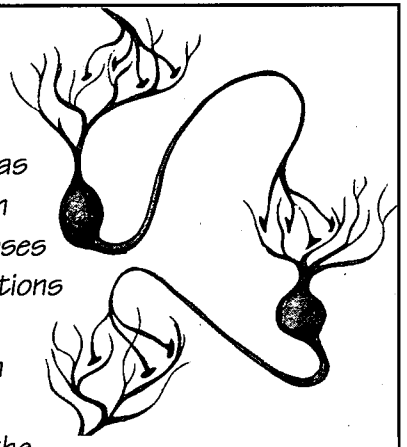
The NeuroExplorers all introduced themselves to Grandpa Miller and told him about the flooding river.

"I'm not sure how we'll get back, Grandpa," said Max. "The bridge is under water, and the roads are closed. Vince said he'd pick us up, but I don't know if he can get over here until the water goes down."

"You know, sometimes I get mixed up about where I'm going, Max," his Grandpa said calmly, "but your Grandma and I used to live right over there. I grew up in these woods, and I helped build the dam. It shouldn't be too far from here. There's a walkway right across the top of the dam that will take us to the other side of the river."

It was true. Max's grandfather had grown up here, and he knew this river and the surrounding woods very well. The NeuroExplorers recalled Professor Ottzinger's words about Alzheimer's disease. While people with A.D. have difficulty remembering directions and can easily get lost, they often have no problem recalling old memories from the past. They would trust Grandpa Miller's memories to lead them out of the woods and over the dam.

The old man pointed to an overgrown path, and the whole group hiked toward the dam. Grandpa Miller stopped when they came to a steep, rocky slope. He turned to Kyle and asked, "Larry, can you and Max help me up this hill?"



Memories are stored in the brain as changes in the synapses or connections among neurons in different parts of the brain. Remarkably, the brain can combine already-stored information with new input from the senses to make decisions and evaluate new situations.

People with Alzheimer's disease have difficulty with the process of forming new memories. Sometimes it helps for them to write things down or to put signs around their homes to help them remember.

Kyle looked at Grandpa Miller, puzzled. Max spoke up, "Don't you mean Kyle, Grandpa?"

"Oh—Kyle. I'm sorry about that. Guess I'm not too good with names these days," Grandpa Miller said. Then he took a pen and a small notebook out of his shirt pocket. "I've been using this notebook to help me remember things," he continued. "Kyle—I'll write that down."

When he finished, he pointed to Isley II and said, "I don't know you. Your name is...?"

"Isley II," the boy replied politely.

As Grandpa Miller began to write the name, he looked up and saw both Isleys, standing together. "Oh, dear," he exclaimed, "there are two of you! Only one is soaking wet." He rubbed his eyes in confusion and stared at the almost identical-looking pair.

"Ah, yes," he said finally, "you must be twins! I didn't know there were twins here." Mr. Miller chuckled, shook his head and wrote in his book,

having forgotten that he met the twins only a short time ago. "Okay, let's get going," he continued. "Somebody give me a hand."

Grandpa Miller put the notebook back in his pocket as Kyle and Max helped him up the steep path. They walked on, looking for the dam. Suddenly, Max stopped and stared at the ground.

Soon the other NeuroExplorers saw what Max saw. Not ten feet away from them, right in the middle of the path, was a colorfully striped snake!

Remembering Rhymes

Grandpa Miller didn't seem to see the snake. He kept walking until he was within two feet of it. Then he stopped and looked down. The NeuroExplorers were horrified. "Grandpa," Max whispered hoarsely.

"Shhh. Be very quiet," Grandpa Miller said, all the time looking at the snake. Then he did something none of the NeuroExplorers could believe. He bent down and gently lifted the snake from the ground! He turned around with the snake in his hands. Eight pairs of wide-open, amazed eyes were staring at Grandpa Miller and the snake.

"Red then black. The snake is striped red then black!" Isley I shouted, with a look of great relief.

"Red then black, friend of Jack," Grandpa Miller said with a smile.

All the NeuroExplorers chanted the poem about snakes that Isley I had told them that morning—

"Red then yellow,
Kill a fellow.
Red then Black,
Friend of Jack."

"You gave us a scare, Grandpa," Max said. "I thought you didn't see that snake and were going to get bit."

"Well, Max, I may have trouble with my memory, but I can see just fine. I learned that poem back when I was in school, you know—red then black," Grandpa Miller said with a grin. He looked at the snake for a minute and mumbled, "Now, what do you call that kind of snake? Uh...I can't seem to remember...milk snake! Yes, there always were milk snakes around here by the river where we built the dam. They look a lot like coral snakes, but their stripes are different...." His voice trailed off.

Grandpa Miller looked away then, as though he had forgotten all about the snake, and where they were, and what they were doing. He gazed off into the distance. Finally he turned back to Max and said, "Now, what were we looking for?"

"Look, there it is! There's the dam just beyond those trees," said Max.

Grandpa put the snake back down on the ground and watched it wriggle off as he said to himself, "I knew the dam was here."

The NeuroExplorers were amazed that, although Grandpa Miller needed a notebook to remember their names and often got lost in new places, he still remembered poems from his school days and the woods he knew so well when he was young. They were glad they'd gotten to meet Mr. Miller. Max was proud of his grandfather, and he smiled as they walked together across the dam.

Just as they noticed the sun getting lower in the sky, they caught sight of Riverbend Gardens. Grandpa Miller paused for a moment and put his hand on Max's shoulder. "You'll come back to see me again, won't you?" he asked.

Max realized that the days he spent with his grandfather now were very important. "Every week, if I can," he answered, putting his arm around his Grandpa's waist. All the NeuroExplorers knew that they wanted to come back, too. This had been a memorable day for everyone!

GLOSSARY

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

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

association (uh-so-see-A-shun) - broad category of learning that involves the formation of mental connections among sensations, ideas, memories and/or movements

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

cerebellum (sehr-uh-BEL-um) - part of the brain located directly above the brainstem that controls the sense of balance and helps the muscles work together for learning and coordination of rote movements

cerebral cortex (suh-REE-bruhl KOR-tex) - the outermost layer of the brain's cerebrum; controls our most advanced abilities, such as speech and reasoning

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

classical conditioning (KLAS-ih-kuhl kon-DISH-uhn-ing) - type of learning by association in which a neutral stimulus (for example, a sound or a light) is paired with a second stimulus that causes a response (for example, the presence of food, which leads to salivation)

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"

disease (diz-EEZ) - sickness; a condition that harms the normal function of some part or parts of the body

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

fracture (FRAK-chur) - a break, especially of a bone

hippocampus (hip-uh-KAM-pus) - a seahorse-shaped area of neurons in each temporal lobe of the brain; forms and stores new memories [plural: hippocampi (hip-uh-KAM-pye)]

imitation (ih-mih-TA-shun) - type of learning that involves observing someone else and copying his or her activity

learning (LERN-ing) - gaining knowledge or skill by instruction, study or experience

lobe (LOHB) - a curved or rounded part of a body organ

long-term memory (LAWNG-turm MEM-uh-ree) - the type of memory that lasts a very long time, even up to a lifetime; for example, your name

memory (MEM-uh-ree) - the act of remembering; information that people or animals have stored in their brains over time

mnemonics (nuh-MON-iks) - systems created to aid memory, such as the use of rhymes or mental pictures that make it easier to remember something

nervous system (NER-vus sis-tum) - the brain, spinal cord and network of nerves 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-jee) - a branch of medical science that deals with the nervous system

neuron (NU-rahn) - a cell of the nervous system that conducts a signal from one part of the body or area of the brain to another

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

Pavlov, Ivan (PAV-lawv, I-vuhn) - Russian scientist who lived 1849-1936 and is best known for his studies of learning and memory in dogs

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

repetition (reh-puh-TIH-shun) - element of many learning processes that involves doing something over and over

short-term memory (SHORT-turm MEM-uh-ree) - type of memory that lasts only for a short time - for example, a telephone number you have just looked up; may be converted to long-term memory

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

synapse (SIHN-aps) - tiny gap between the axon of one neuron and the dendrite of another neuron, across which messages are transmitted chemically or electrically

temporal lobe (TEM-puh-ruhl lohb) - one of the four lobes in the two hemispheres of the cerebrum; located on the sides of the brain and containing the hippocampi, groups of neurons important for learning and memory; located inside the skull just above the ears

Dane Chetkovich was born in West Virginia, grew up in Texas and now resides in San Francisco. He received his M.D. and Ph.D. degrees from Baylor College of Medicine, where he was the recipient of Baylor's highest awards and honors. This story was written while he was still completing his M.D. degree. Dr. Chetkovich specializes in neuroscience and has written several scientific articles about the neuronal basis of learning and memory in mammals. In his free time, he enjoys watching movies, playing golf, and traveling in Mexico and Central America.

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Faculty members in the Division of School-Based Programs at Baylor College of Medicine in Houston, Texas, have developed and revised instructional materials for the BrainLink® project. Judith Dresden, Barbara Tharp and Nancy Moreno have been working together at Baylor for several years on science education projects involving teachers and students from kindergarten through college. All are parents of teenage or grown children. As a team, they also have created instructional materials for the My Health My World™ project, which focuses on environmental health science for elementary school students.

Judith Dresden, originally from New York and New England, formerly conducted educational research and evaluation for public and private schools. Editorial work with a publishing company also led to her current interest in writing and editing stories and science activities for children. She directs the BrainLink project at Baylor and at regional centers around the country. Other projects involve promoting minority students' access to careers in science and the health professions.

Barbara Tharp, originally from California, once worked for the FBI in Washington, D.C., and later was an economic analyst for an oil company. More recently, she has been an elementary teacher specializing in her favorite subjects, science and math. Currently, in addition to creating educational materials, she also enjoys working with many classroom teachers and their students. She directs elementary school teacher enhancement programs at Baylor.

Nancy Moreno, originally from Wisconsin and Michigan, is a biologist who specializes in botany. She spent considerable time studying neotropical plants in Mexico before completing her doctoral degree at Rice University. Current interests include involving scientists in pre-college education. She oversees the science content of Baylor's elementary curriculum development projects and directs the My Health My World project, which builds upon her special interests in ecology and environmental issues.

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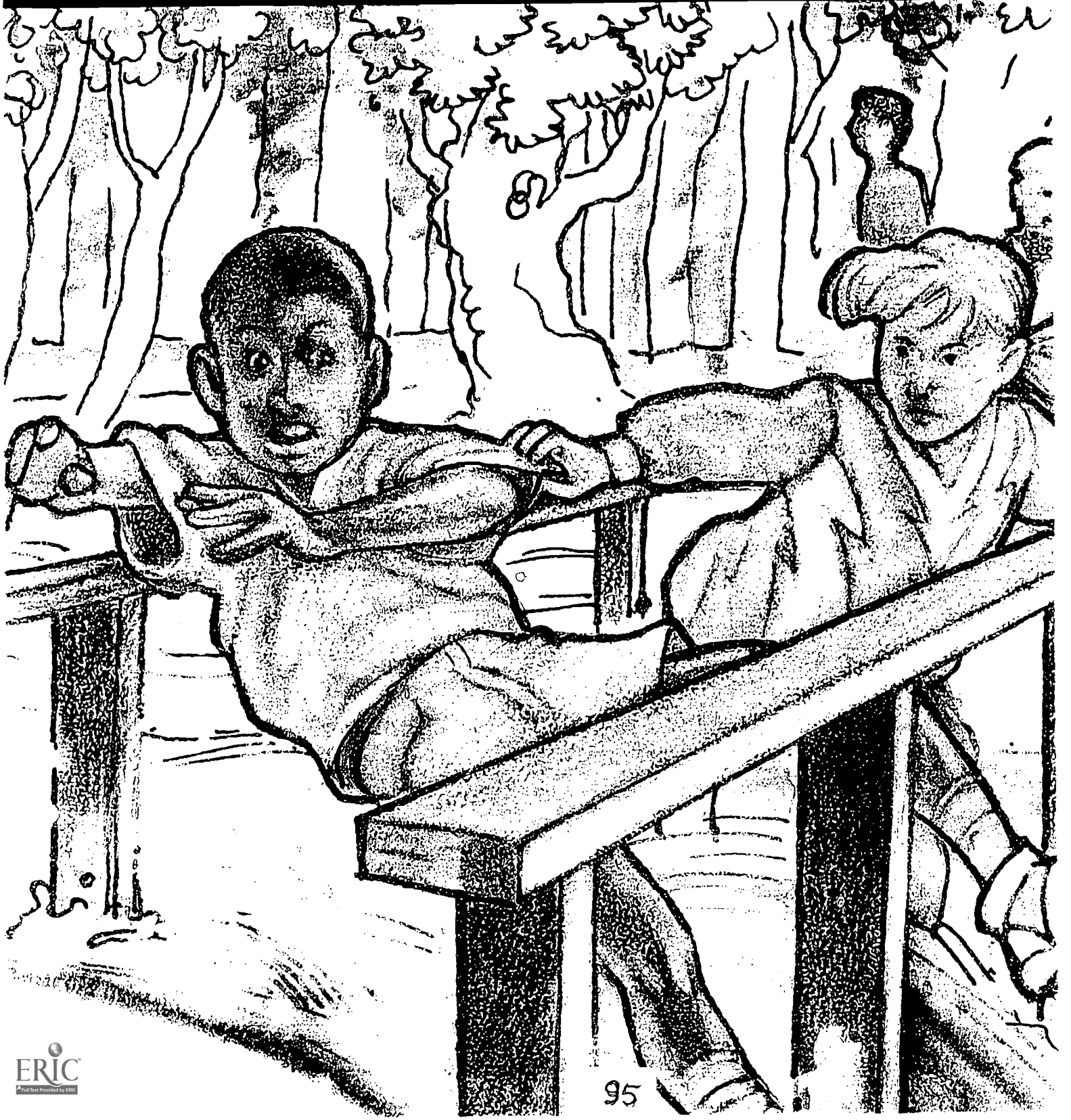
BrainLink
MEMORY & LEARNING

ACTIVITIES

GUIDE FOR TEACHERS



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The Cookie Crumbles
Sensory Signals

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ACTIVITIES

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Memory and Learning

Revised Edition

Nancy Moreno, Ph.D.
Barbara Tharp, M.S.
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Leslie Miller, Ph.D.

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Table of Contents

Science and Health for Kids!

These BrainLink Activities are designed to be used with other components of the Memory and Learning unit:

BrainLink Adventures
Danger at Rocky River: The NeuroExplorers™ in a Memorable Misadventure

BrainLink Explorations
Memory and Learning

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BrainLink Project Director: Judith Dresden, M.S.
BrainLink Project Co-director: William Thomson, Ph.D.
BrainLink Project Faculty: Barbara Tharp, M.S. and Nancy Moreno, Ph.D.

"The brain is the last and grandest biological frontier, the most complex thing we have yet discovered in our universe. It contains hundreds of billions of cells interlinked through trillions of connections. The brain boggles the mind."

James D. Watson
from *Discovering the Brain*
National Academy Press
1992

ABOUT BRAINLINK - Science and Health for Kids!

The BrainLink Project's exciting *Activities*, *Explorations* and *Adventures* "link" students, teachers and parents to advanced knowledge of the brain and nervous system and to vital science and health information. Prepared by teams of educators, scientists and health specialists, each BrainLink unit focuses on a different aspect of the brain and the nervous system. The activity-based, discovery-oriented approach of the BrainLink materials is aligned with the *National Science Education Standards* and the *National Health Education Standards.*

The three components of each BrainLink unit help students learn why their brains make them special.

- *BrainLink Adventures* presents the escapades of the NeuroExplorers Club in an illustrated storybook that also teaches science and health concepts.

- *BrainLink Explorations for Children and Adults* is a colorful mini-magazine full of information, activities and fun things to do in class or at home.

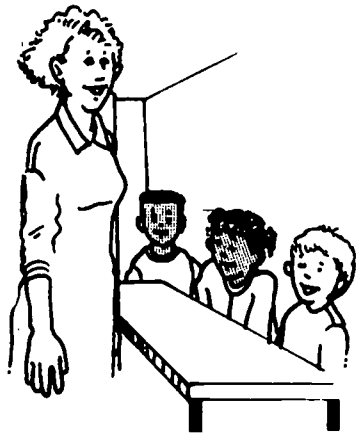
- *BrainLink Activities - Guide for Teachers* presents activity-based lessons that entice students to discover concepts in science, mathematics and health through hands-on activities.

BrainLink materials offer flexibility and versatility and are adaptable to a variety of teaching and learning styles.

WHERE DO I BEGIN?

The *Adventures, Explorations* and *Activities* components of each BrainLink unit are designed to be used together to introduce and reinforce important concepts for students. To begin a BrainLink unit, some teachers prefer to generate students' interest by reading part or all of the *Adventures* story. Others use the cover of the *Explorations* mini-magazine as a way to create student enthusiasm and introduce the unit. Still others begin with the first discovery lesson in the *BrainLink Activities - Guide for Teachers.*

If this is your first BrainLink unit, you may want to use the pacing chart on the following page as a guide to integrating the three components of the unit into your schedule. When teaching BrainLink for 45 to 60 minutes daily, most teachers will complete an entire BrainLink unit with their students in two to three weeks. If you use BrainLink every other day or once per week, one unit will take from three to nine weeks to teach, depending on the amount of time you spend on each session.



The *BrainLink Activities - Guide for Teachers* provides background information for you, the teacher, at the beginning of each activity. In addition, a listing of all materials, estimates of time needed to conduct activities, and links to other components of the unit are given as aids for planning. Questioning strategies, follow-up activities and appropriate treatments for student-generated data also are provided. The final activity in each *BrainLink Activities - Guide for Teachers* is appropriate for assessing student mastery of concepts.

Using Cooperative Groups in the Classroom

Cooperative learning is a systematic way for students to work together in groups of two to four. It provides an organized setting for group interaction and enables students to share ideas and to learn from one another. Through such interactions, students are more likely to take responsibility for their own learning. The use of cooperative groups provides necessary support for reluctant learners, models community settings where cooperation is necessary, and enables the teacher to conduct hands-on investigations with fewer materials.

Organization is essential for cooperative learning to occur in a hands-on science classroom. There are materials to be managed, processes to be performed, results to be recorded and clean-up procedures to be followed. When students are "doing" science, each student must have a specific role, or chaos may follow.

The Teaming Up model* provides an efficient system. Four "jobs" are delineated: Principal Investigator, Materials Manager, Reporter, and Maintenance Director. Each job entails specific responsibilities. Students wear job badges that describe their duties. Tasks are rotated within each group for different activities, so that each student has an opportunity to experience all roles. Teachers even may want to make class charts to coordinate job assignments within groups

Once a cooperative model for learning has been established in the classroom, students are able to conduct science activities in an organized and effective manner. All students are aware of their responsibilities and are able to contribute to successful group efforts.

* Jones, R. M. 1990. Teaming Up! LaPorte, Texas: ITGROUP.

Memory and Learning
Sample Sequence of Activities, Adventures and Explorations

The components of this BrainLink unit can be used together in many ways. If you have never used these materials before, the following outline might help you to coordinate the Activities described in this book with the unit's *Adventure* story (*Danger at Rocky River*) and *Explorations* mini-magazine (*Memory and Learning*).

Similar information also is provided for you in the Links section of each activity in this book.

Activity	Concepts	Class Periods to Complete Activity	Links to Other Components of Unit	
			Adventures: Rocky River	Explorations: Memory and Learning
1. Memory Is a Backpack	There are several kinds of learning.	1	Read: Red then Yellow; Brain Power	Memories poem (p 2)
2. Memory Challenge	Declarative memory is concerned with people, facts and events.	3	Read: Remembering an Old Friend; Tricks of the Memory	Cover; Gray Matters (p 2); Memory Power (p 5)
3. Memorable Moments	Short-term and long-term are two stages of memory.	1 or more	Read: The Hippo Takes a Dive; Good Dog With a Bad Memory	Gray Matters (p 2); Pavlov's Dogs (p 6); Careers (p 5)
4. Mirror Writing	Procedural memory is our memory of how to do things.	1 or more	Read: How Are Your Hippocampi?; Max's Fear; A Warning	Gray Matters (p 2); Back cover
5. A-Mazed	Learning is a complex process.	2	Read: Games and Grandparents; A Raging River; Water Power	Gray Matters (p 2); Decade of the Brain (p 4)
6. Profiles in Learning	There are a variety of learning disorders.	1	Read: Looking for Grandpa; Confusing Questions	Inventor Thomas Edison (p 6); The Neuro Side (p 7)
7. What's Your Story?	Summary and assessment activity	1	Read: Remembering Rhymes; Grandpa's Victory	Use Your Brain - Promote Your Health (p 4)

Materials

You will need the following materials to teach this unit.

- small trays or plates (one per group) (Activity 2)
- paper towels (one per group) (Activity 2)
- 10-15 different small objects (per group) (Activity 2)
- dice (one per group) (Activity 3)
- small game pieces (12 per group) (Activity 3)
- small unbreakable mirrors (one per student) (Activity 4)
- card stock or heavy paper (one letter-sized sheet per student) (Activity 5)
- school glue (at least one container per group) (Activity 5)
- sand or glitter (or glitter pens) (4 oz per group) (Activity 5)
- empty cereal boxes (one per pair of students) (Activity 5)
- watches or clock with a second hand (Activity 5)

Call 1-800-969-4996 for information about BrainLink printed materials and supplies.

Memory is a Backpack

BRAINLINK BACKGROUND (for the teacher)

Memory and Learning

We learn continuously throughout our lives. Every day, new information enters our brains, is processed and is stored in a way that allows it to be found again and used. The "storerooms" in our brains hold memories of all the people we have known and experiences we have had, emotions we have felt, facts we have learned, skills we have mastered and all of our vocabularies and knowledge of languages.

When information is kept in the brain in a way that allows it to be found and used later, we say that it has been learned. Learning is closely coupled to memory. Once we have "learned" something, we can recall it from memory, or "remember" it. In other words, learning is the process of acquiring information or skills. Memory refers to the recall of stored knowledge or skills.

Sometimes we make a conscious effort to learn something—when we play new music on the piano, for example. Other times, we learn things without any effort at all. Have you ever found yourself singing a jingle that you have heard on the radio or TV, but never tried to learn?

Types of Learning

Even very simple animals are capable of some kinds of learning. They can, for example, adjust their responses to light or to being touched based on past experience. In higher animals, including humans, most learning involves the formation of associations. When we learn by *association*, we make connections among sensations, ideas, memories and responses. If your cat or dog runs to the kitchen when you open the refrigerator, it probably has learned to associate the sound of the door with being fed.

Often, associative learning is combined with other ways of learning. For example, human babies learn language by imitating the adults and older children around them and by associating the sounds they make with different outcomes. *Imitation* is an important component of many kinds of learning, such as learning to speak, tie a shoelace or shoot a basketball.

Repetition also is an important element of many learning processes. We say phone numbers several times to ourselves to help us remember them. We repeat our baseball or tennis swings to improve the coordination of our movements. As young children, we even practiced walking until we became skilled!

ACTIVITY 1

CONCEPTS

- Learning is the process of acquiring information and skills.
- Memory is the recall of stored information.
- There are several types of learning.

OVERVIEW

Students will experience examples of different types of learning by memorizing a poem that is accompanied by hand and body movements.

SCIENCE & MATH SKILLS

Communicating, inferring

TIME

Preparation: 20 minutes
Class: 45 minutes

MATERIALS

- optional overhead transparency or copies of the poem "Memories"

Classical Conditioning

Classical conditioning, described by Ivan Pavlov, is one kind of learning by association. Pavlov, who studied digestion in dogs, observed that the mere sight of food would cause them to salivate. He trained dogs to stand quietly in harnesses and, after the sound of a bell, fed them meat powder. He observed when the dogs salivated. After repeating the experiment a few times, he found that the dogs would salivate when the bell rang, before they received the meat powder. They had learned, or been conditioned, to react to the bell the same way they responded to the presence of food.

Since our brains continuously receive new information from the sensory system (eyes, ears, nose, tongue and skin), we learn many things without consciously trying. Learning is not something that happens only in school! To observe this kind of learning (sometimes called *latent learning*), try moving a common object, such as the trash can, to a different spot in your classroom. How many times do your students go to the old place?

This activity allows students to experience learning through association, imitation and repetition by memorizing and performing a poem accompanied by hand movements.

LINKS

This activity may be taught along with the following components of the Memory and Learning unit.

***Danger at Rocky River* chapters:**

Red Then Yellow
Brain Power
NOTE: If this is your students' first BrainLink Adventure story, have them read the introductory sections—The Beginning and The Club Members—before continuing with the rest of the book.

***Explorations*:**

Memories Poem (page 2)

SET-UP

This activity should be conducted with the entire class.

PROCEDURE

1. Prior to beginning this activity, prepare yourself by reading and practicing the poem, "Memories," using the hand motions described in the box and illustrated on page 4. The suggested motions should become smooth and easy to remember after a few tries. Feel free to modify the motions for your class.

2. Talk about memory and learning with the class. Ask for ideas about what memory is and how it is useful. *What does it mean to learn something or remember something? What do memory and learning have to do with each other?*

3. The poem "Memories" presents one way to think about learning and memory. Introduce it to your students in one or more of the following ways.

   - Read it aloud from the *Explorations* of this unit.

Repetition is an important way of learning.

Memories

Your memory is a backpack
Touch upper back with hands
Where you keep all your notes –
Writing motion, one hand writing on other
All the ones you want to keep,
Pull hands into chest, holding something
And even those you don't.
Make throwing away motion
It takes them and it files them
Gathering motion, pulling toward waist
In pockets made for you
Bring hands down and into pockets (pants, jacket or imaginary)
They all have special places,
Touch hands to top of head
Some for longer, it is true.
Spread arms far apart
There's a place for short-term memories
Quickly and lightly touch sides of head with hands
Of what happened just today,
Point index fingers down in front of body
But lots of long-term space, as well,
Extend arms outward, indicating a large space
For things that need to stay.
With both hands, push "memories" into head, nodding as if saying, "yes"

- Project an overhead transparency of the illustrated poem given on page 4 of this book.
- Give each child a copy of the illustrated poem.

4. Read or recite the poem for the class, using the hand motions given. Then, let your students join you in saying the poem and performing the movements along with it. Try it several times.

   Possible variations

   - Break the members of the class into small groups; let them practice and then come back together to perform the poem with movements.
   - Divide the class into three or six groups, with each group assigned to one verse or two lines of the poem. Bring them all together to perform the poem as a round robin.

5. Suggest/describe/reinforce how the students learned the poem by *imitation* (watching the teacher), *repetition* (saying and/or doing something over and over, practicing or rehearsing) and *association* (connecting the words with the motions).

6. Repeat the poem and the motions later in the day and/or for the next few days. Then ask, *Do you remember most of the words and motions of the poem, "Memories"? Have you learned the entire poem?* Talk about how learning has been taking place. Ask, *What helped you learn the poem?*

BRAIN JOGGING

Here are more ideas for you and your students to explore.

- Would it be possible to spend an entire day without learning a single thing? How about without using your memory?
- What are some things that you have learned by watching and doing the same thing as someone else? How about by practicing?
- Do animals remember? What types of things might animals remember? How do you think different kinds of animals learn?

Imitation is another way in which we learn.

Instinct

Some kinds of knowledge already are "wired" into the nervous system at birth—like a baby's knowing how to smile at his or her mother or a bird's knowing how to build a nest. This is known as instinct.

Habituation

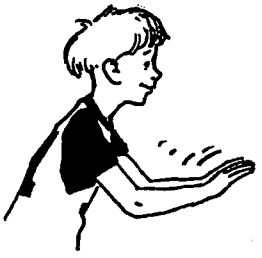
Becoming used to a repeated stimulus (like a loud noise) is called habituation. For example, you might be startled or jump the first time someone blows a loud whistle. After a while, however, if the sound is repeated with no ill effects, you will stop jumping every time you hear it. On the other hand, if something painful happens along with the loud sound, your reaction to the whistle will be more exaggerated the next time you hear it. An increase in the response to a stimulus is called sensitization. This is a very basic kind of learning.

Memories

Your memory is a backpack

Where you keep all your notes -

All the ones you want to keep



And even those you don't.

✣ ——— ✣

It takes them and it files them

In pockets made for you.

They all have special places,

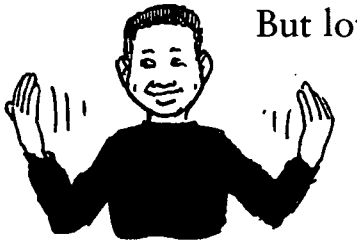
Some for longer it is true.

✣ ——— ✣

There's a place for short-term memories

Of what happened just today,

But lots of long-term space, as well,



For things that need to stay.

Memory Challenge

BRAINLINK BACKGROUND (for the teacher)

Who, What, Where and When

Our "memory banks" hold records of our past, including our experiences and what we have learned about people, places, events and facts. These types of memories—memories of what we have experienced and learned—are processed and stored in pathways in the cerebral cortex. This form of memory often is called *declarative memory*, because it can be recalled and stated, or declared, "Yesterday, I ate a peanut butter sandwich for lunch," or, "Nine times eight equals 72."

Declarative memories are processed and stored separately from memories of how to do things, which are stored in the cerebellum. That form of memory, called procedural memory, is highlighted in Activity 4, "Mirror Writing."

Improving Memory

There are many ways to improve our performances in certain kinds of declarative memory tasks. Known as *mnemonics*, these strategies make it easier to remember names, dates or lists. A few mnemonic techniques are listed below.

- *Rhythm and rhyme* form the basis of many simple memory boosters. For example, a tricky grammatical rule is easy to remember when stated as: "*I* before *E* except after *C*."

- *Acronyms and phrases* provide hints that help us remember long strings of names or lists. The acronym, "ROY G. BIV," has helped countless numbers of students remember the colors of the spectrum (red, orange, yellow, green, blue, indigo, violet). The first letters of the words in the phrase, "My Very Energetic Mother Just Served Us Nine Pizzas," makes it easier to remember the names and order of the planets in our solar system.

- Mental images can be useful for recalling names and lists. To remember the name of someone you have just met, construct

ACTIVITY 2

CONCEPTS

- Memories of what we have learned about people, events and facts are called declarative memories.
- These memories are processed and stored in the cerebrum.

OVERVIEW

Students will compare different strategies for memorizing information such as names, dates and lists.

SCIENCE & MATH SKILLS

Observing, comparing, computing, summarizing, graphing

TIME

Preparation: 15 minutes
Class: 45 minutes to conduct experiment; 45 minutes for calculations and graphing; 45 minutes for follow-up graphing activity

MATERIALS

- small trays or plates (one per group)
- paper towels or napkins to cover the trays (one per tray)
- enough small objects, such as buttons, toys, pencils, etc., to prepare a different tray of 10-15 items for each group of four students (use 10 items for younger students; older students will enjoy the challenge presented by up to 15 items)

a mental image that links the person's appearance to his or her name. For example, picturing Mrs. Green in a green dress may make it easier to remember her name.

- *Grouping* unrelated items into categories or lists helps break strings of information into bits that are easier to remember. Phone numbers are easier to recall as one three-digit and one four-digit number than as one series of seven numbers. Items are even easier to remember when organized into meaningful groups.

LINKS

This activity may be taught along with the following components of the Memory and Learning unit.

***Danger at Rocky River* chapters:**

Remembering An Old Friend
Tricks of Memory (see science box on page 6)
Also see science box on page 3

***Explorations*:**

Cover activity
Gray Matters (pages 2 and 3)
Memory Power (page 5)

SET-UP

This activity is best conducted with the students in groups of four, followed by a whole class discussion of observations and results.

PROCEDURE

Conducting the Tests (45 minutes)

1. Assemble enough small objects to place 10-15 items on a tray or plate for each group of four students. Each tray should have a different assortment of items. Hide the contents of the trays by covering them with napkins or paper towels.

2. Distribute a covered tray or plate to each table of four students. Every student should have a pencil and a sheet of paper. Explain to the students that they will be learning something new and creating memories.

3. Let a student in each group uncover the tray. Tell the students to study the trays individually for five minutes, without talking or touching the objects. After five minutes, have the students cover the trays. Immediately, ask if they think they have created a memory of the items on their trays. Have each student list as many of the objects as he or she can remember. (Note: You may find that more or less time is

Students should study the objects on the tray.

appropriate for your group of students. The time allowed for each of the trials, however, should be the same.)

4. Have each student count items that he or she remembered. Have younger students add their values and record the total number of items remembered by the members of the group. Older students should compute the average number of items remembered in their group and/or class.

5. Rotate the trays around the classroom, so that each group will have a set of objects to observe. This time, tell the groups to construct an acronym or a funny sentence based on the first letters of each of the objects. Students may touch or arrange objects and work together. Allow the groups five minutes to work. Then tell them to cover the trays and ask the students to list the objects on their sheets of paper. Ask, *Were you able to remember fewer or more items than you were during the first time? How useful was the word or phrase in helping to remember the objects on the tray?*

6. Again, have the groups tabulate their results and record group and/or class averages or totals. Let the groups share their acronyms and phrases with the rest of the class.

7. Rotate the trays again. Ask the members of each group, working together, to sort the objects on the tray in any way that is meaningful to them and might help them to remember the objects. Give them five minutes for the task.

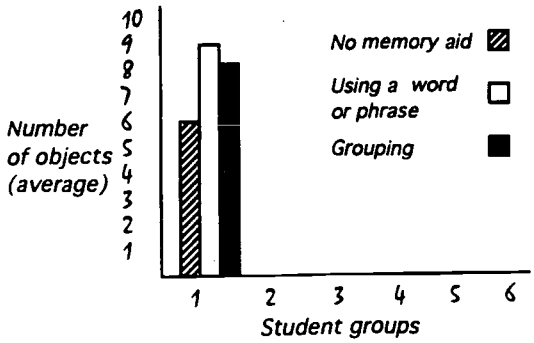
8. Have them cover the trays and, again, ask the students to list as many items as they can remember on their sheets of paper. Ask, *Were you able to remember fewer or more items than the time you simply observed the objects on the tray?*

Tabulating Results (45 minutes)

1. Have the groups tabulate their results and compute group and/or class averages or totals. Older students should compare the results of the three trials as a bar graph.

2. Ask the students, *Which method was most effective in helping to remember the objects? Did some of you find one way to be more effective, while others found the other to be more useful? What does this tell us about ways in which we learn and remember? Which method might help you remember the items for the longest period of time? Are there any practical applications of these memory tools?*

3. Explain to the students that they have been using one kind of memory—the memory of "what" (objects, facts, people and events). This kind of memory is handled by the cerebral cortex. Ask the students to name other examples of their "what," or declarative, memories.



Sample graph of numbers of objects recalled using different memory techniques

4.. Many games and puzzles rely on information stored as declarative memory. Challenge your students to create their own "Brain-nastics" games. OR Have them think of other games they play at home or at school that use information from their memories of "who, what, where and when."

Follow Up (45 minutes)

1. After a few days, ask the students to record the items they remember from the three different trays. Again ask them to calculate totals per group, or averages, and graph as before.

2. Students should discuss the later graphs and compare them with the first graphs. Ask the students, *Are there differences? Why might there be? Can any conclusions be drawn regarding different memory techniques?*

BRAIN JOGGING

Here are more ideas for you and your students to explore.

- What we experience is not always recorded accurately in declarative memory. Our memories of events can be influenced by our emotions and by things that happen later. Can you think of any times when your memory of an event or object was not accurate or did not agree with someone else's?

- Choose something that happened recently in your classroom. Let everyone in the class write down a description of that event, including as many details as possible. Do all of the descriptions agree? What do you think might have caused differences among the descriptions?

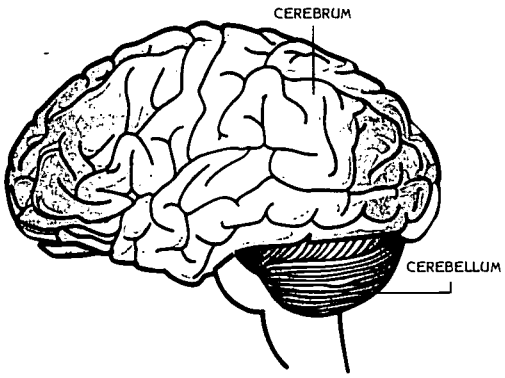
Memorable Moments

BRAINLINK BACKGROUND (for the teacher)

Where Are Memories Held in the Brain?

For many years, scientists looked for a single place in the brain where memories might be stored. They now believe, however, that such an area does not exist. Instead, memories are stored as changes in connections between neurons in many different places in the brain. These changes involve either the growth of new nerve connections (new synapses) or the strengthening of existing ones.

Several different areas of the brain have been identified as important for learning and memory. The role of the cerebellum for storing memories of how to do things (procedural memories) is highlighted in Activity 4, "Mirror Work." Other types of



memories, especially those of people, facts and events, are stored in the cerebrum. This type of memory (highlighted in Activity 2, "Memory Challenge") is called declarative memory, because it can be recalled and stated, or declared. Areas deep inside the brain help process many kinds of memories—not only memories of facts, but also of emotions—and make them permanent.

Stages of Memory

Learning and memory depend on input from the senses into the brain. All sensory input (even input from muscles) is held briefly in the brain. For example, for approximately one tenth of a second, we have total photographic recall of everything we have just seen!

Part of the information that comes into the brain is transferred to *short-term memory*, where it can be held for several minutes. Some things in short-term memory are moved to *long-term memory*, especially when they are rehearsed or practiced. On the other hand, visual information and some of our experiences (especially if they are traumatic, exciting or

ACTIVITY 3

CONCEPTS

- Short-term memories last only a few minutes; long-term memories last from a few hours to a lifetime.
- There are different pathways in the brain for processing memories.
- The hippocampus is important for forming long-term memories.

OVERVIEW

Students learn about the transfer of knowledge from short- to long-term memory as they play a board game illustrating basic memory processes.

SCIENCE & MATH SKILLS

Problem-solving, counting, communicating

TIME

Preparation: 20 minutes
Class: 20 minutes to color boards and review rules, 30 minutes to play games at least twice and 20 minutes to discuss game process.

MATERIALS

- copies of "Memorable Moments" game boards (see center insert in this book)
- for each gameboard you will need:
  - 1 die
  - 12 small game pieces (three each of four different colors)
  - copy of "Memorable Moments Rules" on page 12
  - copy of "Brain Flash Cards" cut into cards (pages 13-14)
  - copy of "Experience Cards" cut into cards (pages 15-16)

significant in other ways) are stored in long-term memory even when they are not repeated. Memories that are considered long-term can last for a few hours up to an entire lifetime.

The Case of H. M.

An amazing case history in neuroscience showed that declarative memories (our memories of facts, events and people) and procedural memories (our memories of how to do things) are processed independently in different areas of the brain. This case, described at right, provided evidence to identify one of the brain structures important in converting some short-term memories to long-term ones.

Study of the cases of H.M. and others led neuroscientists to the conclusion that the hippocampus was critical for the transfer of many kinds of information from short-term to long-term memory. One sea horse-shaped hippocampus is located deep within each half of the cerebral cortex (both were removed from H.M.). Without the hippocampus, many kinds of memories never become stored in long-term memory. Damage to the hippocampus is one of the earlier effects of Alzheimer's disease and leads to losses in the ability to form new lasting memories of people, places and events.

Not all memories are processed through the hippocampus. The cerebellum is responsible for storing memories of movements and procedures. This is why H.M.'s ability to learn new motor skills and to improve them over time was not impaired. One of the activities that H.M. was able to learn to do very well was "mirror" writing, as in Activity 4, "Mirror Writing."

The "Memorable Moments" game in this activity helps students learn about the formation of short- and long-term memories. It shows the involvement of the hippocampus in processing memories, illustrates the path of memories formed by vivid or significant experiences, and demonstrates the role of repetition in forming some kinds of memories.

LINKS

This activity may be taught along with the following components of the Memory and Learning unit.

Danger at Rocky River Chapters:
- The Hippo Takes A Dive
- Good Dog with a Bad Memory (see box on page 11)
- Also see science box on page 8

Explorations:
- Gray Matters (pages 2 and 3)
- Pavlov's Dogs (page 6)
- Careers for NeuroExplorers (page 7)

The Remarkable Case of H.M.

H.M.* was a patient who underwent drastic brain surgery to treat severe epilepsy. Although the epilepsy was controlled, H.M.'s memory was dramatically affected by the procedure. He no longer was able to put many kinds of new information, particularly relating to people, events and facts, into long-term memory. He could not remember his own experiences, except for those that occurred before the surgery.

Other aspects of H.M.'s memory were not impaired. In addition to memories of his life, his vocabulary, and facts he had learned before surgery, he still was able to retain information for a few minutes in short-term memory. He also was able to learn and remember new motor skills. Neuroscientists working with H.M. concluded that the structure removed from H.M.'s brain, the hippocampus, was responsible for converting information from short- to long-term in declarative memory, but not for storing it. Other research showed that long-term memories of this kind are held in various areas of the cerebral cortex.

The case of H.M., originally published by B. Milner in 1966, has been described extensively in numerous neuroscience reference texts. For further reading, see: Thompson, R. 1993. The Brain: A Neuroscience Primer. W.H. Freeman & Company, New York.

* Every effort is made to protect the privacy of patients whose cases are documented in scholarly medical reports. For this reason, patients are never identified by name. Initials (usually not the correct ones) are used instead.

SET-UP

You will need to make copies of the game board pages inserted in the center of this guide. You may want to mount the gameboards on cardboard or laminate them after they have been colored by students.

Have students play the game in groups of up to four. Afterward, conduct a discussion with the entire class about how memories are processed.

PROCEDURE

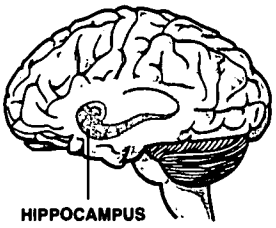
1. Tell the story of H.M. to your students. Challenge them to imagine what life would be like without the ability to form many kinds of long-term memories. Stress the role of the hippocampus in processing memories of "who, what, where and when" for long-term storage in the cerebral cortex.

2. The Memorable Moments game boards should be colored before they are used. Distribute the boards among the groups of students and have them follow the coloring instructions located on the board.

3. Have the students play the Memorable Moments game in groups of 2-4, following the rules of play shown on "Memorable Moments - Rules." Older students may be able to read and follow the instructions independently. Younger students will need to have the rules of play explained to them.

4. After all students in the class have had an opportunity to play the game one or more times, initiate a discussion on the differences between short- and long-term memory. Ask the students, *Can you think of kinds of information that usually are held in short-term memory and then are lost? How about kinds of information that we remember for a long time? Can we make long-term memories if the hippocampus doesn't do its job?*

5. Using the brain picture in other components of this unit, *Explorations* or *Danger at Rocky River*, point out the locations of the hippocampus, the cerebral cortex and the cerebellum.



The hippocampus is important for forming long-term memories.

BRAIN JOGGING

Here are more ideas for you and your students to explore.

- Think of five things that often are held in short-term memory without being transferred to long-term memory.
- What is the hardest thing you ever worked to get into your long-term memory? What did you do to get it there?

Memorable Moments
A Game for 2-4 Players

Rules of Play

1. Each player receives 3 game pieces of the same color or shape. The first player to place all 3 game pieces into Long-Term Memory wins.
2. To begin, all players place their game pieces inside the Home space. Each player rolls the die once. The player who rolls the highest number starts.
3. Players take turns, clockwise, rolling the die. A player must roll an odd number in order to move a game piece from Home to Start. When a game piece is placed on Start, the player immediately should pick an Experience Card. The instructions on the Experience Card tell the player which path to follow and how many spaces to move (or direct the player to roll to see how many spaces to move). The Experience Card should be placed on the bottom of the pile after the turn.
4. Once a game piece is started along a path, rolling the die or following instructions on a card will determine the number of spaces that the piece may move during a turn. Only one game piece may be moved at a time. The total number shown on the die may not be split among two or more game pieces on the board. When a "1," "3" or "5" is rolled, the player may choose between moving another game piece out of Home and selecting an experience card or moving a game piece already on a path.
5. Two or more game pieces may occupy the same space on the board.
6. When a player lands on a Brain Flash space, the player to his/her left reads the top Brain Flash card to him. Instructions given by Brain Flash cards should be followed as directed. If the card asks a question, the player on the space must try to answer. If the correct answer is given, he/she receives an extra turn. Each Brain Flash card should be placed on the bottom of the pile after use.
7. Players must roll the exact number of spaces needed in order to enter Long-Term Memory. Once a game piece has been placed in Long-Term Memory, it cannot be removed.

Brain Flash Cards

Which part of the brain handles memories of well-learned movements?

(cerebellum)

Choose one of your game pieces already on a path and move it 5 extra spaces.

Where does most thinking and learning happen in the brain?

(cerebrum or cerebral cortex)

Choose one of your game pieces already on a path and move it 6 extra spaces.

What is the kind of memory that lasts from several hours to a lifetime?

(long-term memory)

Choose one of your game pieces already on a path and move it 4 extra spaces.

What is the kind of memory that doesn't last very long

(short-term memory)

What is the seahorse-shaped part of the brain that is important for memory?

(hippocampus)

What is another name for a nerve cell?

(neuron)

What is the command center of the body?

(brain)

Brain Flash Cards Continued

Choose one of your game pieces already on a path and move it back 5 spaces.

What do you call tricks to help you remember facts or lists?

(mnemonics)

What are the wrinkles on the brain called?

(gyri)

Choose one of your game pieces already on a path and move it back 3 spaces.

Which branch of science studies the nervous system?

(neuroscience)

Choose one of your game pieces already on a path and move it back 1 space.

Which part of the brain connects to the spinal cord?

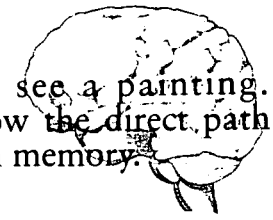
(brainstem)

Choose one of your game pieces already on a path and move it 5 spaces forward.

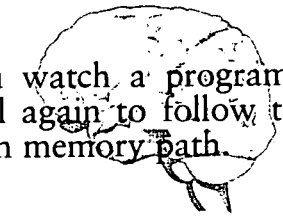
Choose another player's game piece and move it backward one space.

Choose another player's game piece and move it forward 5 spaces.

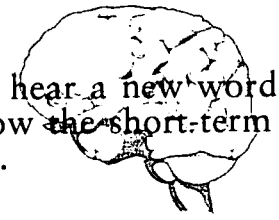
Experience Cards



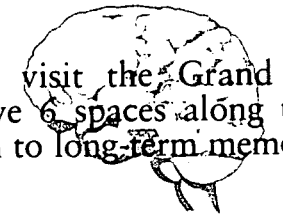
You see a painting. Roll to follow the direct path to long-term memory.



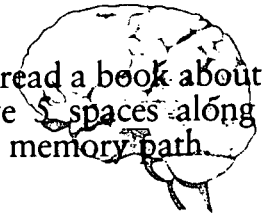
You watch a program on TV. Roll again to follow the short-term memory path.



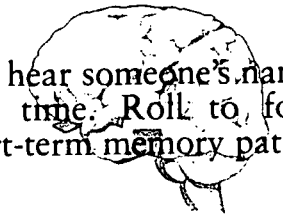
You hear a new word. Roll to follow the short-term memory path.



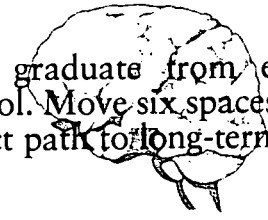
You visit the Grand Canyon. Move 6 spaces along the direct path to long-term memory.



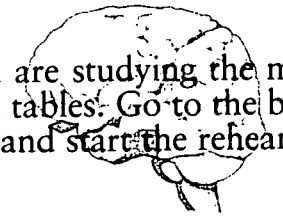
You read a book about dinosaurs. Move 5 spaces along the short-term memory path.



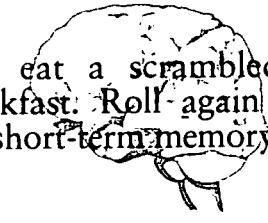
You hear someone's name for the first time. Roll to follow the short-term memory path.



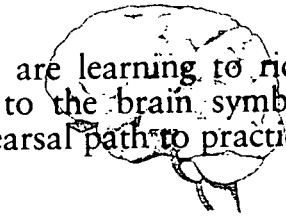
You graduate from elementary school. Move six spaces along the direct path to long-term memory.



You are studying the multiplication tables. Go to the brain symbol and start the rehearsal path.



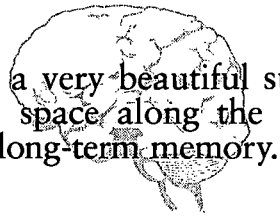
You eat a scrambled egg for breakfast. Roll again to follow the short-term memory path.



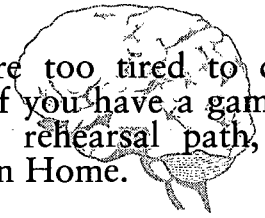
You are learning to ride a bike. Go to the brain symbol on the rehearsal path to practice.

Experience Cards

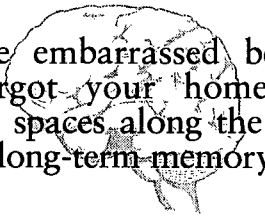
You see a very beautiful sunset. Move 1 space along the direct path to long-term memory.



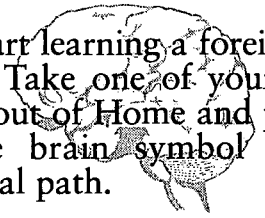
You are too tired to concentrate. If you have a game piece on the rehearsal path, put it back on Home.



You are embarrassed because you forgot your homework. Move 3 spaces along the direct path to long-term memory.

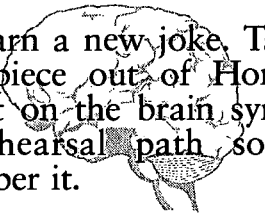


You start learning a foreign language. Take one of your game pieces out of Home and place it on the brain symbol in the rehearsal path.

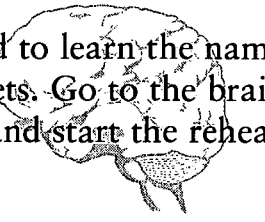


Loud music interrupted your thinking. Return one game piece to Home.

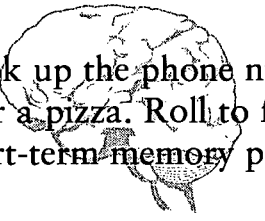
You learn a new joke. Take one game piece out of Home and place it on the brain symbol in the rehearsal path so you'll remember it.



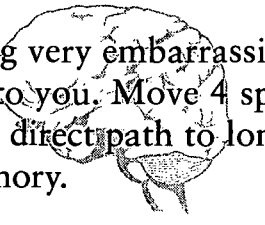
You need to learn the names of the planets. Go to the brain symbol and start the rehearsal path.



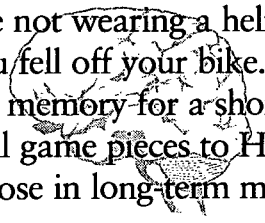
You look up the phone number to order a pizza. Roll to follow the short-term memory path.



Something very embarrassing happens to you. Move 4 spaces along the direct path to long-term memory.



You were not wearing a helmet when you fell off your bike. You lose your memory for a short time. Return all game pieces to Home except those in long-term memory.



Memorable Moments Game Board

Rules of Play

1. Each player receives 3 game pieces of the same color or shape. The first player to place all 3 game pieces into Long-Term Memory wins.
2. To begin, all players place their game pieces inside the Home space. Each player rolls the die once. The player who rolls the highest number starts.
3. Players take turns, clockwise, rolling the die. A player must roll an odd number in order to move a game piece from Home to Start. When a game piece is placed on Start, the player immediately should pick an Experience Card. The instructions on the Experience Card tell the player which path to follow and how many spaces to move (or direct the player to roll to see how many spaces to move). The Experience Card should be placed on the bottom of the pile after the turn.
4. Once a game piece is started along a path, rolling the die or following instructions on a card will determine the number of spaces that the piece may move during a turn. Only one game piece may be moved at a time. The total number shown on the die may not be split among two or more game pieces on the board. When a "1," "3" or "5" is rolled, the player may choose between moving another game piece out of Home and selecting an experience card or moving a game piece already on a path.
5. Two or more game pieces may occupy the same space on the board.
6. When a player lands on a Brain Flash space, the player to his/her left reads the top Brain Flash card to him. Instructions given by Brain Flash cards should be followed as directed. If the card asks a question, the player on the space must try to answer. If the correct answer is given, he/she receives an extra turn. Each Brain Flash card should be placed on the bottom of the pile after use.
7. Players must roll the exact number of spaces needed in order to enter Long-Term Memory. Once a game piece has been placed in Long-Term Memory, it cannot be removed.

See Page 12 For a Student Page of Rules.

Brain Flash Cards Here

Memorable Moments

Roll a 1, 3 or 5 to move one game piece fm Home to Start. Immediately pick an experience card and follow the instructions t move along a path to Long-Term Memory.

Place Experience Cards Here

COLORING INSTRUCTIONS

- Color spaces 1-7 GREEN.
- Color spaces 8-15 BLUE.
- Color spaces 16-21 PURPLE.
- Color spaces 22-31 ORANGE.
- Color spaces 32-44 RED.

HOME
u must roll
odd number
o place a
me piece in
START.

SHORT-TERM MEMORY PATH

SHORT-TERM MEMORY

DIRECT PATH TO LONG-TERM MEMORY

REHEARSAL PATH

LONG-TERM MEMORY PATH

BRAIN FLASH

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44

3 You were distracted. Experience is forgotten. Go back to Home.

4 Go ahead 4 spaces.

6 You're fast. Go to the hippocampus.

7 Go back 4 spaces.

8 You have entered Short-Term Memory. Roll again.

10 You need practice. Take the rehearsal path.

11 Oops! Your experience is forgotten. Go to Home.

13 Place one game piece on Start and draw an experience card.

15 Pass through hippocampus to reach Long-Term Memory

16 HIPPOCAMPUS

17 Go back 4 spaces.

19 Go ahead 3 spaces.

20 Extra time for processing. Lose 1 turn.

21 Almost there. Roll again.

22 START OF REHEARSAL

23 You learned something else. Place 1 game piece from Home on the hippocampus.

25 You finished practicing. Go to Long-Term Memory.

27 Go back spaces.

29 You need to concentrate. Skip 1 turn.

31 You need more work. Go to start of rehearsal.

33 This is a vivid experience. Go directly to long term memory.

35 Processing problem because you skipped breakfast. Lose 1 turn.

38 You have another experience. Take one game piece out of Home and use it on

40 Go back 2 spaces.

42 You had a good night's sleep. Roll again.

43 Go back to Home.

44 Go ahead 1 space.

Long-Term Memory

1-800-969-4996

BrainLink® Activities
Developed by
Baylor College of
Medicine
Houston, Texas

Mirror Writing

BRAINLINK BACKGROUND (for the teacher)

When we are very young, we learn basic skills like walking and reaching to grasp objects. Later, we master more complicated movements, such as writing, playing sports or dancing. With practice, our performance of these tasks improves. Procedures such as these, which are learned movements, are stored as motor programs in the cerebellum. Your students already may have learned about programs for movements in the activity, "Practice Makes Perfect," in the BrainLink Motor Highways Unit.

Memories of procedures are processed and stored in the brain independently of memories about facts, names, places and events. In fact, this type of memory, called *procedural memory*, also can be thought of as our knowledge of "how" to do things. Procedural memories often are difficult to describe. (For example, try explaining how to ride a bicycle to someone.)

Repetition, or learning by doing something over and over, often is important for making procedural memories. The following activity provides an example of procedural memory formation by challenging students to learn a new physical skill and to improve it through practice.

LINKS

This activity may be taught along with the following components of the Memory and Learning unit.

Danger at Rocky River chapters:
- How Are Your Hippocampi? (see box on page 12)
- Max's Fear
- A Warning
- Also see science box on page 20

Explorations:
- Gray Matters (pages 2 and 3)
- Activity on back cover

SET-UP

This activity is best conducted with the students working individually or in pairs (to take turns with mirrors), followed by a whole class discussion of observations and results.

ACTIVITY 4

CONCEPTS

- Procedural memory is our memory of how to do things.
- The cerebellum is important for storing procedural memories.
- Repetition is important in forming procedural memories.

OVERVIEW

Students experience how a new motor skill improves with practice.

SCIENCE & MATH SKILLS

Observing, comparing observations, drawing conclusions

TIME

Preparation: 5 minutes
Class: 30 minutes; second optional session of 30 minutes

MATERIALS

Each student will need:
- small unbreakable mirror
- copy of "Mirror Work" on page 19
- pencil

PROCEDURE

1. Give each student a copy of the Mirror Work page and a small plastic mirror.
2. Direct each student to hold his or her mirror so that the reflection of one of the shapes on the Mirror Work page can be seen easily.
3. Tell the students to trace between the lines of each shape as accurately as possible, while looking only in the mirror.
4. Have the students compare their first efforts with their last. Ask, *Did it become easier to draw the figures after a few times? Why do you think it became easier? Have you learned a new skill?*
5. If time permits, allow students to test their mirror-writing skills again a day or two later. Ask, *Was the mirror-drawing easier this time than the first time you tried it? What kind of memory have you formed?*

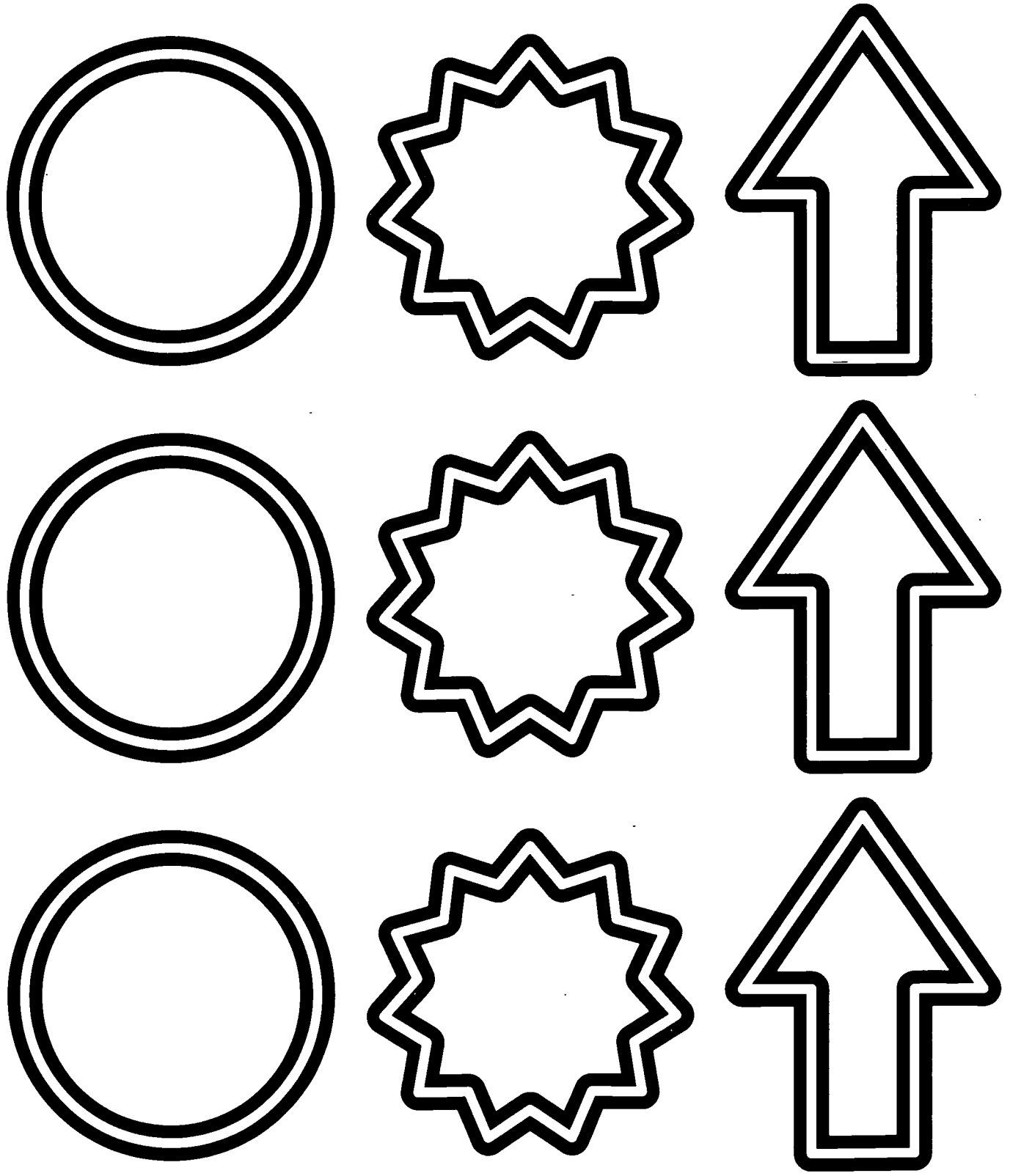
Have students trace between the lines on the Mirror Work sheet, while looking only in the mirror.

BRAIN JOGGING

Here are more ideas for you and your students to explore.

- Name some everyday activities that rely on procedural "how-to" memories.
- What would happen if we were not able to learn and improve our physical skills by practicing? Think of several examples.
- B. J., one of the NeuroExplorers, is an avid drummer. Do you think she had to practice to become skilled? How about Kyle's abilities to play video games?

Mirror Work



A-Mazed

BRAINLINK BACKGROUND (for the teacher)

The brain continuously uses knowledge already stored in memory to evaluate new situations and to make decisions. Remarkably, it is able to combine stored information with new sensory input to refine existing knowledge. For example, on the first day of school, new students might know how to reach their classrooms, but not the cafeteria. By the second day, they also will know how to walk to the cafeteria, but may not have explored the school well enough to be able to locate the library. After a few weeks, however, most will have a good picture of the layout of the school in their "minds' eyes," and would be able to draw a map of the school. Each day, new information has been added to the mental image of the school stored in the brain.

Usually, several distinct parts of the brain work together to receive and integrate new information. In this activity, students will solve mazes using touch information received through their fingertips. At first, they will not be able to envision how the maze is configured. After a few tries, however, they will find that they are able to picture the correct path through the maze clearly in their minds. This example of trial and error learning involves several different stages of information processing, some of which may occur almost simultaneously in separate regions of the brain.

A simplified description of the processing that occurs in the brain is given on the facing page. Building a mental map from touch and joint position information is a complex task. The brain must put together different kinds and pieces of information about the maze pattern in space. Then it must create an image in the "mind's eye" from the combined information. Although very few studies have been done examining the changes in brain activity during this type of information processing, present evidence indicates that the creation of the mental image requires actual activation of parts of the vision area of the cerebral cortex. It is amazing that the brain can perform this type of complex operation, and even more amazing that we do this type of processing all the time, without even being aware of what we are doing!

LINKS

This activity may be taught along with the following components of the Memory and Learning unit.

Danger at Rocky River Chapters:
- Games and Grandparents
- A Raging River
- Water Power

Explorations:
- Gray Matters (pages 2 and 3)
- Decade of the Brain (page 4)

ACTIVITY 5

CONCEPTS

- Learning is a complex process.
- The brain is able to receive and integrate new information with existing knowledge.

OVERVIEW

Students explore more complex processes of learning by solving a maze using the sense of touch.

SCIENCE & MATH SKILLS

Measuring variables, comparing measurements, predicting, charting and drawing conclusions

TIME

Preparation: 20 minutes
Class: 30 minutes to make mazes; 30 minutes to test mazes

MATERIALS

- copies of "Maze Patterns" on pages 23 - 26 (one maze per student)
- heavy paper or card stock (either photocopy or glue mazes onto heavy paper or card stock)
- school glue
- sand or glitter (or use "glitter pens," which already contain glitter mixed with glue)
- empty cereal boxes
- watches or clock with a second hand

SET-UP

Have 2-4 students work together to share materials as they make the mazes. Have them work in pairs to experiment with the mazes.

PROCEDURE

Making the Mazes (30 minutes)

1. Give one maze to each student, distributing all 4 mazes evenly throughout the class. Have the students glue the mazes onto heavy paper or cardstock, if this has not been done already.

2. Ask the students to solve their mazes with a pencil. Ask, *Was it difficult to find your way through the maze?* Now have the students try to solve the mazes with their eyes closed. Ask, *Could you solve it this time? What is the problem? What information is needed? How could you get the needed information?* Guide the students toward a discussion of the role of other senses in providing information. In this case, the sense of touch could help them solve the maze with their eyes closed. Explain that they will use touch to explore the mazes.

3. Direct the students to apply a narrow line of glue over all of the pathways on their mazes, including the square at the beginning of the maze and the triangle at the end. Next, have them place segments of spaghetti or sprinkle sand or glitter on the wet glue lines. If using sand or glitter, have the students do the sprinkling over a box or newspaper. Let the mazes dry. ("Glitter" pens recently have appeared in school supply sections of stores. They also work well for outlining the mazes.)

Using the Mazes (30 minutes)

1. Explain to the students that they will solve the mazes using only the sense of touch. (No peeking allowed!) Discuss the difficulties that might be encountered when the maze cannot be seen. Also ask, *Do you think that you will become "better" or faster at completing the maze with practice? What might happen to account for a change in "maze-solving speed"?*

2. Arrange the students in teams of two to begin their experiments. Have one student of each team place his/her maze inside a cereal box with the starting square at the closed end of the box. Direct the other student of each pair to place his/her hand inside the box and feel for the starting square at the far end. Once the square is located, the student

Creating a Mental Image from Touch Information

(1) Touch information from the fingertips is sent to the cerebral cortex.

(2) Information about the finger's joint position is sent to the cerebral cortex.

(3) Each type of sensory information is processed separately.

(4) Touch and joint position information are combined.

(5) Combined information is transformed into information about arrangement and position (spatial information).

(6) A mental image of the spatial information is created.

(7) The mental image is stored in memory.

(8) With each additional exploration of the maze, the mental image is compared with new information about the maze.

(9) The mental image stored in memory is adjusted with each exploration until a complete image of the maze is formed in memory.

should begin to trace the maze with a finger, while the other student records the time it takes the "a-mazed" student to complete the first and subsequent trips through the maze.

Results should be recorded on a simple table as shown. Each student should make at least three trips through the maze.

3. Let the pairs of students switch roles and mazes and repeat the experiment. Have older students graph the results.

4. Have the students look at the results of the trips through the mazes. Ask, *Did the maze become easier to solve? Did you learn which branches led to "dead ends"? Did you become faster at moving through the maze? What could account for the difference?*

5. Challenge the students to think about the paths that they followed to complete the mazes successfully. Ask, *Can you "see" the maze pattern in your "mind's eye"?*

6. Leaving the mazes in the boxes (so that they cannot be seen), ask the students to draw their maze paths as they remember them on clean sheets of paper. Have them compare their drawings to the actual mazes. Ask, *What type of sensory information did you use to solve the maze? How close is your drawing to the real path?*

7. With the entire class, share the BRAINLINK BACKGROUND as appropriate for your grade level. It is important to note that there are many processes going on in the brain to make the leap from tactile exploration of the maze to ease in remembering the path in your "mind's eye." You might ask questions such as, *Which parts of the brain are involved in processing touch information about each maze? Cerebral cortex? Cerebrum? Motor cortex? What does this tell us about the location of learning and memory in the brain?*

Have students time each other as they solve the tactile mazes.

Trial	Time (seconds)
1	
2	
3	

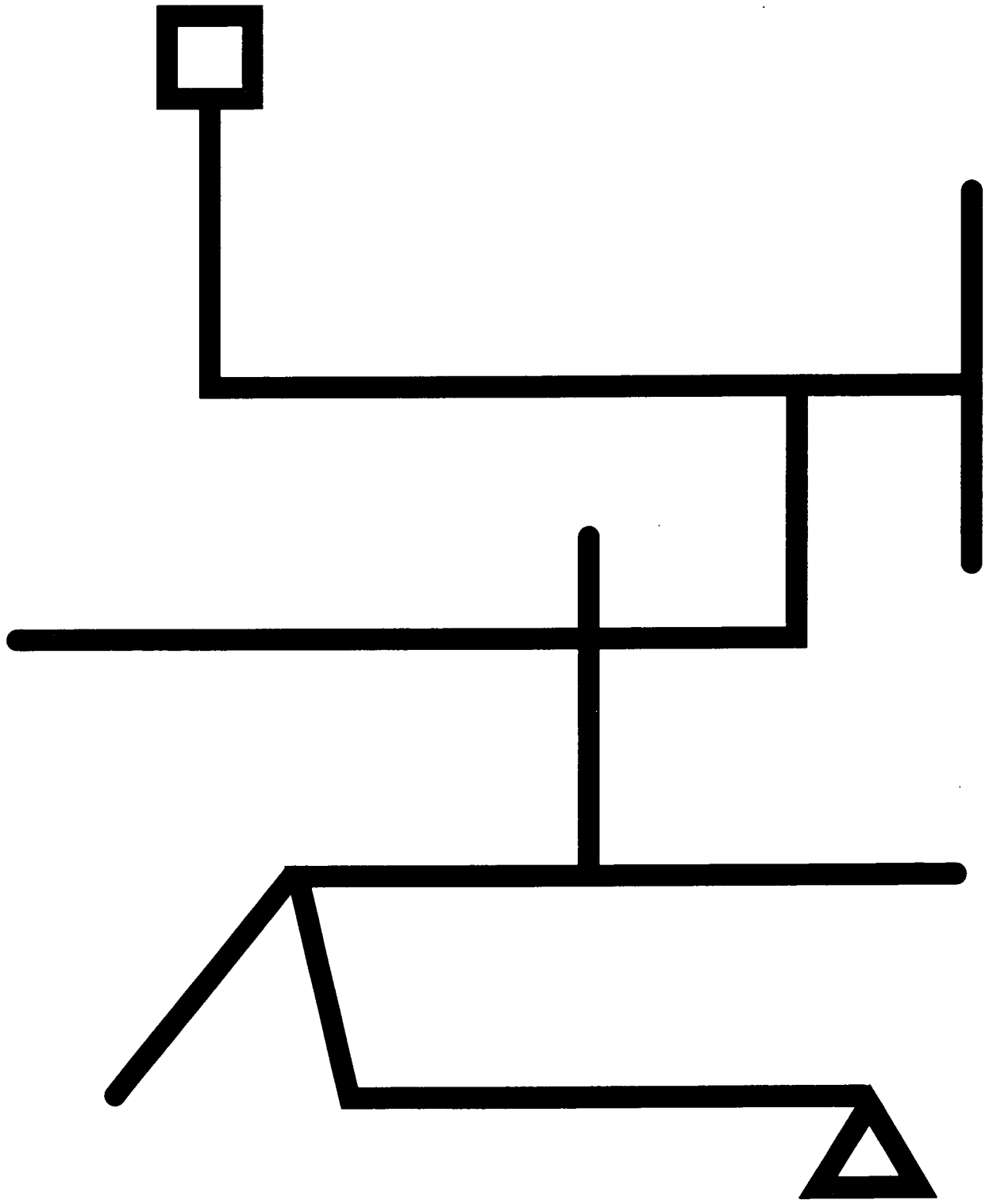
Make a table of the times required to solve maze during successive trials.

BRAIN JOGGING

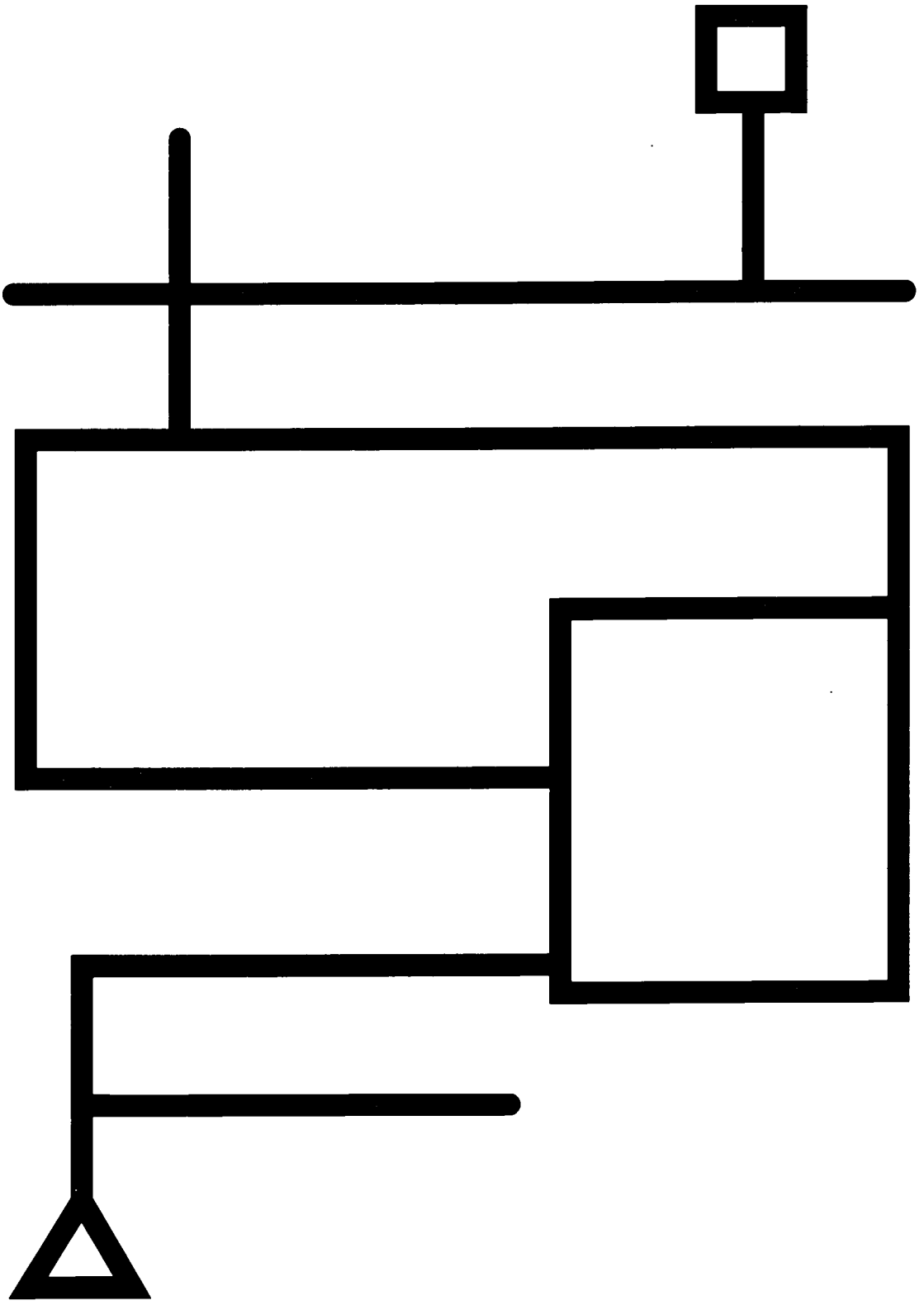
Here are more ideas for you and your students to explore.

- What are some other activities in which you have to see with your mind's eye?
- What other senses do you use for learning?
- Learning to solve the mazes in this activity is one example of learning by trial and error (or association, as mentioned in Activity 1). How might the ability to learn through experience be important for the survival of any animal?
- How might another person who cannot see or hear use another sense to enable his or her brain to learn about what is going on around him or her?

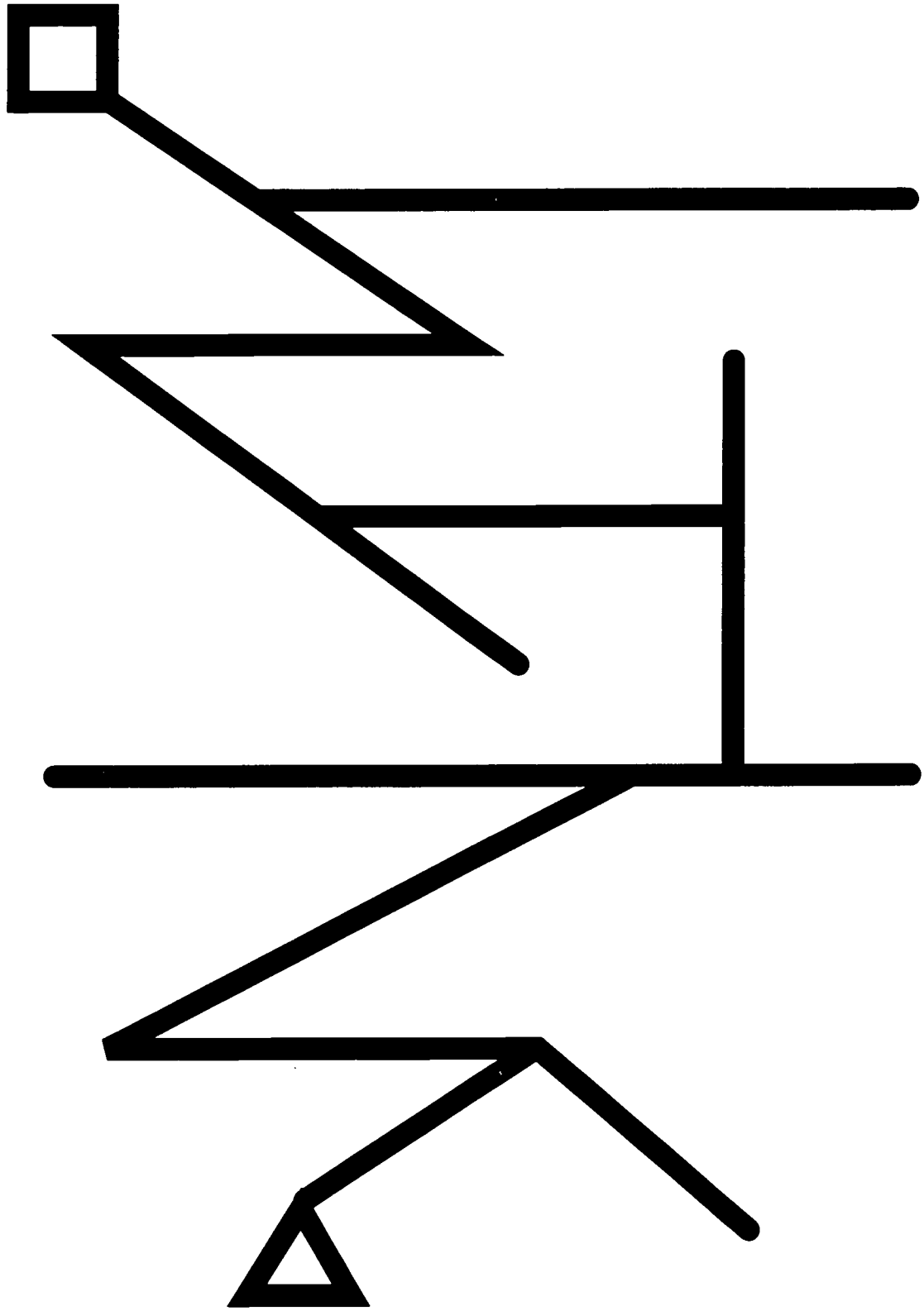
Maze Pattern 1



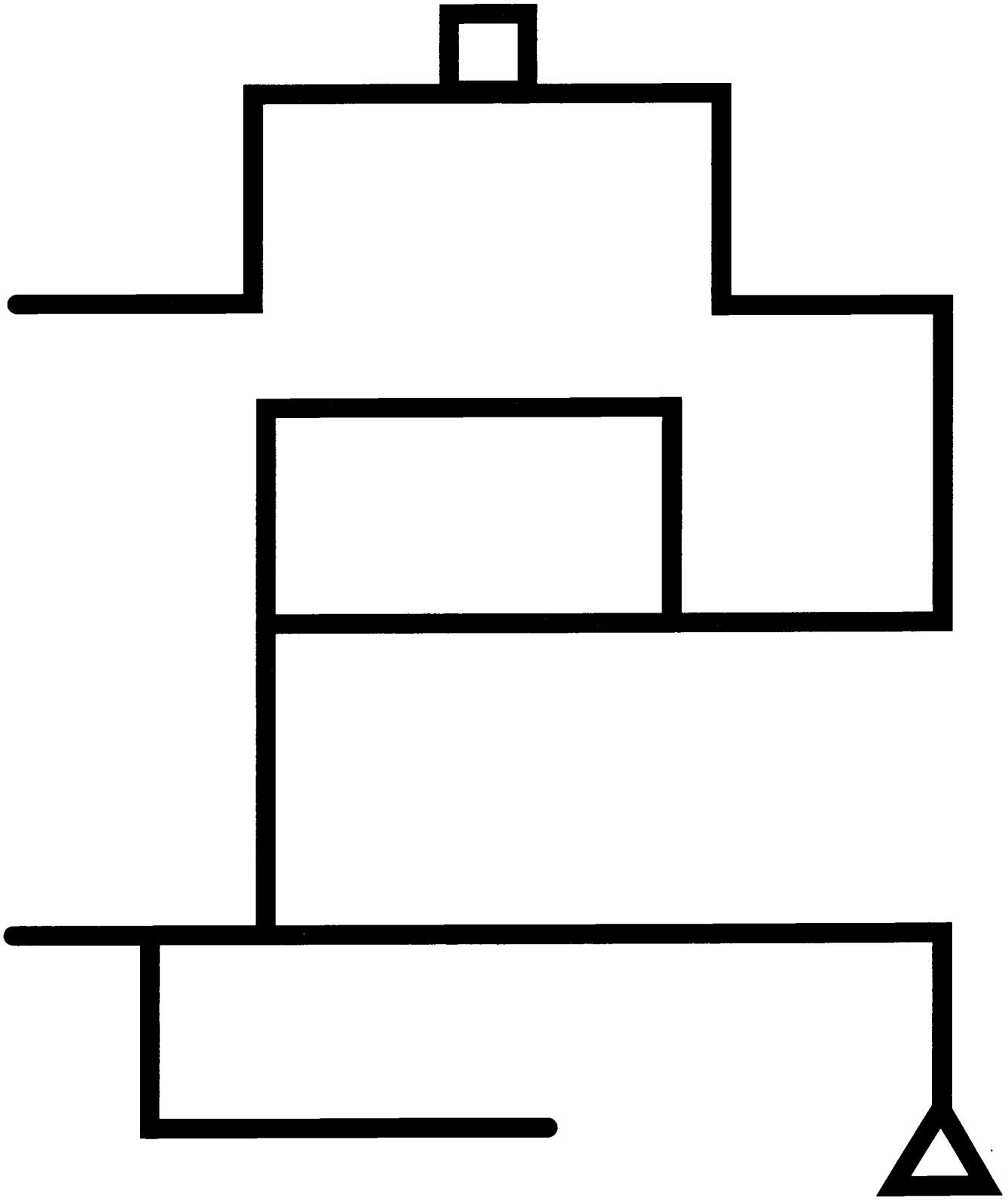
Maze Pattern 2



Maze Pattern 3



Maze Pattern 4



Profiles in Learning

BRAINLINK BACKGROUND (for the teacher)

About ten percent of people in the United States have "learning disabilities," which make it much more difficult for them to learn in traditional ways.

There are many kinds of learning difficulties. A common problem that gives many students trouble in school is called dyslexia (diz-LEK-see-uh). Dyslexia is a difference in brain functioning that can make it very hard for people to learn in school. It usually affects reading and spelling, but it can take a variety of forms, sometimes including difficulty with mathematics, remembering what is seen or heard, putting thoughts into words orally or on paper, or even organizing materials. A person with dyslexia may have any combination of these problems. Characteristics of attention deficit/hyperactive disorder (ADHD) also can be involved. In fact, professionals do not always agree on a precise definition of dyslexia.

Usually, letters and figures look different to a person with dyslexia than to other people. They may appear "scrambled" in some way because of differences in "wiring" in the brain. A simple example of reading and writing problems caused by dyslexia is shown in the Explorations component of this BrainLink unit.

Additional information can be acquired from the resources listed at the end of this activity, from local schools or organizations specializing in learning disorders, or from the library.

Dyslexia creates different learning patterns from the average, so persons with this problem must be taught in different ways. With special help, children with dyslexia can become successful adults who can make significant contributions to society.

LINKS

This activity may be taught along with the following components of Memory and Learning unit.

Danger at Rocky River Chapters:
- Looking for Grandpa
- Confusing Questions (see science box on page 28)
- Also see science box on page 13

Explorations:
- Inventor Thomas Edison (page 6)
- The NeuroSide (page 7)

SET-UP

This activity may begin with a class discussion, followed by reading of the biographical essays, or vice versa. With younger

ACTIVITY 6

CONCEPTS

- Dyslexia is a common learning disorder.
- Many successful people have learning disorders.

OVERVIEW

Students read four essays about successful people who have overcome a variety of learning differences. References are provided to stimulate further exploration of learning disabilities.

SCIENCE & MATH SKILLS

Communicating, applying prior knowledge to new situations and using reference materials

TIME

Preparation: 10 minutes
Class: 45 minutes

MATERIALS

- copies of biographical essays: "Turning on the Light," "The Politician Who Had Trouble With Words," "A Dream Come True" and "Courageous Adventurer, Polar Explorer" on pages 30-33
- copies of "Famous People Who Had Difficulty in Learning" on page 34

students, you may want to read the individual biographies to the class and then conduct a discussion. Otherwise, individuals or groups can be given reading assignments and then asked to find further information either about the persons or about dyslexia and other forms of learning disabilities from the library or from the suggested source organizations.

PROCEDURE

1. Lead a class discussion about differences in learning styles and patterns. *Some of us find it easy to spell, and some of us have to work very hard at it. Some are better at math and some at reading or writing. Different learning patterns are normal. However, some people's brains work very differently, so that it is much harder for them to learn to read and spell words, even though they may be very intelligent. When this is the case, someone who specializes in learning disabilities can find out how to help them learn more easily.*

2. Continue the discussion by telling the class that some children have a kind of learning difficulty that is called dyslexia. Ask students if they have heard of dyslexia. Write the word on the board, and practice pronouncing it. Let them share any experiences that they or someone they know may have had with this kind of difficulty and look for common characteristics. See if they can come up with a definition for dyslexia, which can be revisited after the students have read the Profiles in Learning.

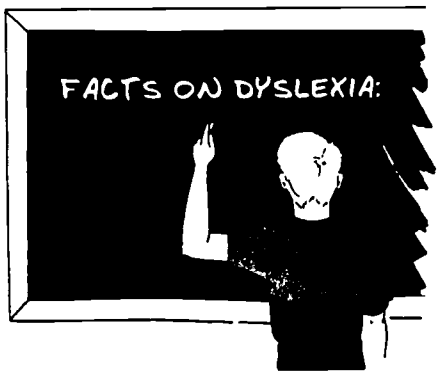
   OR

   Without talking about dyslexia, tell the members of the class that they are going to read (or hear) some stories about people who have had difficulties in learning.

3. Depending on the age of the students, either distribute the Profiles in Learning reading selections or read them to the class. You may prefer to read or tell one story a day to younger children. Older students may be divided into four groups, giving a different selection to each group.

4. Have individual students tell the class about the selections that were read. If groups read different selections, have a student from each group present his or her story to the class. As the stories are told, list on the board—or let a student list—(1) facts about dyslexia, and (2) ways to cope with and work around such a problem.

5. Share the list of other famous people who have had similar learning disabilities.



Create lists of information about dyslexia and coping strategies.

6. Encourage students to learn more about this and other learning difficulties or about other people with learning disabilities by contacting local or national organizations or by visiting the library.

BRAIN JOGGING

Here are more ideas for you and your students to explore.

- Write a short story or diary entry from the point of view of a person who has difficulty in school because he or she learns in different ways from other students.
- What do all of the people whose "profiles" you read have in common besides dyslexia?

REFERENCES for Profiles in Learning Essays

"A Calendar of Outstanding Dyslexics: An Inspiration for Success." Los Angeles: Orton Dyslexia Society, 1993.

American Women's Expedition, 2110 Laurelwood Dr., Thousand Oaks, CA 91362.

Conot, Robert. A Streak of Luck: The Life & Legend of Thomas Alva Edison. New York: Seaview, 1979.

Dillman, Erika. "Leader of the Pack: Ann Bancroft, Explorer." Runner's World, January, 1994.

Donovan, Robert J. Confidential Secretary: Ann Whitman's 20 Years with Eisenhower and Rockefeller. New York: E. P. Dutton, 1988.

Josephson, Matthew. Edison: A Biography. New York: McGraw Hill, 1959.

Lampton, Christopher. Thomas Alva Edison. New York: Franklin Watts, 1988.

Persico, Joseph. The Imperial Rockefeller: A Biography of Nelson A. Rockefeller. New York: Simon & Schuster, 1982.

Steger, Will with Paul Scherke. North to the Pole. New York: Times Books, 1987.

Thompson, Lloyd J. Language Disabilities in Men of Eminence. Bulletin of The Orton Society, Vol. XIX, 1969.

Wenzel, Dorothy. Ann Bancroft: On Top of the World. Minneapolis: Dillon Press, 1990. (Students may enjoy reading this book.)

RESOURCES

The Council for Exceptional Children

1920 Association Drive
Reston, VA 22091

Association of Children and Adults with Learning Disabilities

4156 Library Road
Pittsburgh, PA 15234

Orton Dyslexia Society

724 York Road
Baltimore, MD 21204

Also contact local schools and organizations specialized in learning disorders.

The Politician Who Had Trouble With Words

On December 19, 1974, Nelson Rockefeller became Vice-President of the United States. Being in public office was nothing new to Mr. Rockefeller. He had been Governor of New York for 15 years, having been elected four times to that office.

Some said that Nelson Rockefeller's success in reaching such high positions was helped by being born into a very wealthy family. His grandfather, John D. Rockefeller, was once the richest man in the world. But there was something else that kept Nelson striving to reach his goals. It was something he learned as a boy, as he struggled to cope with a "learning disability" called dyslexia (diz-LEK-see-uh).

Dyslexia is a difference in brain functioning that can make it difficult for people with average or above-average intelligence to read, write or spell. When Nelson was in school, people didn't know about dyslexia. Although he was outgoing and had the makings of success, Nelson was a poor student. Neither he nor anyone else could understand why he had such trouble reading or why he confused words and mixed up numbers.

In an interview when he was 68 years old, Nelson Rockefeller told about his difficulties in school: "I saw words backwards. Or I repeated them backwards. Even today, if I just glance at something, I still get mixed up...I have no confidence in reading....I can't see a whole word. I have to go through it syllable by syllable."

Rockefeller nearly failed ninth grade and was in the bottom third of his high school class. When he realized that he might not be accepted into college in spite of all his money, Nelson learned that "I had to be determined and I had to discipline myself in order to overcome it... to be an achiever. You have to have a strong sense of courage to overcome something like this." With all his advantages, Rockefeller might have been tempted to give up and take an easy way out. Instead, he worked hard with tutors, and eventually he was able to go to college.

During his career, Rockefeller served under six of the seven United States presidents between 1940 and 1977. He was an outstanding politician and leader, even though, as his long-time secretary said, "He was terrible at dictating letters and speeches. He fragmented sentences...."

A speech writer of Rockefeller's wrote in a book about him, "Rockefeller overcame, or at least learned to deal with, his dyslexia. As he grew older, Nelson came to believe that his determination had turned his handicap to advantage." As Nelson Rockefeller put it: "Accept the fact you have a problem. Don't try to hide it. Refuse to feel sorry for yourself. You have a challenge. — Never quit!"

Turning On the Light

I remember I used never to be able to get along at school. I was always at the foot of the class. I used to feel that the teachers did not sympathize with me, and that my father thought I was stupid. I almost decided that I must be a dunce.

Those were the words that Thomas Alva Edison used to describe himself. He was an American inventor who lived from 1837 to 1931. It is hard to imagine that such a brilliant and famous person had so much trouble learning!

When he was eight years old, Thomas Edison heard his teacher say that his mind was "addled" (mixed up or confused). It is clear, from the stories told by his teachers, his family and by Edison himself, that he had real learning difficulties. He may have had what is now known as dyslexia (diz-LEK-see-uh). Young Thomas was upset because he had so much trouble learning, and so was his mother. She was a teacher, and she found it hard to believe what Thomas' teacher had said about her own son.

Mrs. Edison removed her son from school and decided to teach him herself. She encouraged him by reading to him and helping him find new ways to learn. When he was nine, she gave him a book about science experiments, and he tried out every experiment in the book. His mother saw how excited he was, and she gave him other books that interested him. It was clear that Thomas' brain worked differently from other children's, and his mother helped him to learn in different ways. "My mother was the making of me," Thomas Edison later recalled.

While his mother helped him follow his interests and worked with him every day, she was unable to help him overcome some of his learning difficulties. People wrote in his biographies that he never learned to spell and that his grammar was terrible.

But Edison's difficulties did not stop him. He stuck with things until he figured them out. That is how he invented the light bulb. He tested more than 3,000 different materials until he finally found one, carbonized cotton thread, that could carry an electric current without burning up. "The electric light has caused me the greatest amount of study and has required the most elaborate experiments ... [but] I was never, myself, discouraged," he explained.

In addition to the light bulb, Edison created the phonograph, the electric generator, the electric locomotive, the mimeograph and the alkaline storage battery. Over his lifetime, he was granted over 1,000 patents for his inventions. He was a pioneer in the electric power industry, without which we wouldn't have radio, television or computers today.

In spite of having to overcome learning difficulties as a child, Thomas Edison changed the world! Maybe those difficulties even helped him want to keep plugging away at things until he figured out how to make them work. Think about it the next time you turn on a light!

Courageous Adventurer, Polar Explorer

The wind howled, and they could hardly see through the blowing snow as they skied over solid ice. Each member of the group pulled a 200-pound sled full of supplies. Their faces were frozen, and they were exhausted. Their legs and arms ached. They had pulled their sleds over an ice drift that was ten feet high. The four adventurers were determined to reach the South Pole. They skied on into the wind, over the vast icecap of the antarctic continent.

On January 14, 1993, the American Women's Expedition reached its goal. The team had skied for 67 days in the constant daylight of the antarctic summer, in 30-degree-below-zero temperatures. This courageous group had covered 660 miles to become the first women ever to reach the South Pole on foot. They used no dogs or motorized vehicles, because they didn't want to harm the environment. Ann Bancroft headed the expedition. She was their leader, their coach, and their inspiration.

This was not the first challenge that Ann Bancroft had tackled. She already had become the first woman to reach the North Pole by dogsled, as part of another expedition in 1986. Now she had become the first woman to reach both the North and South Poles across the ice. Success was not new to her, for she always worked very hard to do her best.

When Ann was in elementary school, she tried hard to do well, but she did not always succeed. In fact, her grades were very low. Neither she nor anyone else could understand why it was so hard for her to read and spell. She became discouraged, and the only parts of school she liked were recess and gym class.

In the seventh grade, Ann took some special tests and was told that she had dyslexia (diz-LEK-see-uh). As she later described this problem, "When I tried to read, signals on the nerve paths to my brain got mixed up, so letters and numbers seemed scrambled." Having a name for her difficulty didn't make it easier, but she kept trying to find ways to succeed.

In high school, Ann became an excellent athlete. She played basketball and was a runner on the girls' track team. She loved camping and hiking in the summer. School still was hard for her, but she finished high school and decided to go to college. It always was a struggle, but she wouldn't give up, because she wanted to become a teacher. Finally, she graduated from the University of Oregon.

Ann Bancroft had done the impossible. She, who had thought she couldn't learn, was a teacher! She taught physical education and special education in her home state of Minnesota. She also was an expert mountain-climber and reached the top of Mt. McKinley, the highest peak in North America.

Now, in the icy glare at the South Pole, Ann knew again what it was like to face a very hard task, and to keep at it until you succeed!

A Dream Come True

Meet Dr. Garth O. Vaz, Medical Director of the Gonzales Community Health Center in Gonzales, Texas. On any day of the week, you might find him examining a patient's swollen ankle or listening as a patient describes the pain in her lower back. Dr. Vaz is one of only a handful of doctors in a small town. He works day and night, and he wouldn't have it any other way. Being a doctor is something Garth Vaz had wanted for most of his life—and it was a long time coming.

When he was a boy on the island of Jamaica, Garth had difficulty in school. He was good at math, but he could not seem to learn to read or write. In those days in Jamaica, students got a "flogging" (were hit with a stick or paddle) when they failed. Garth didn't like the floggings, and he left school in the ninth grade.

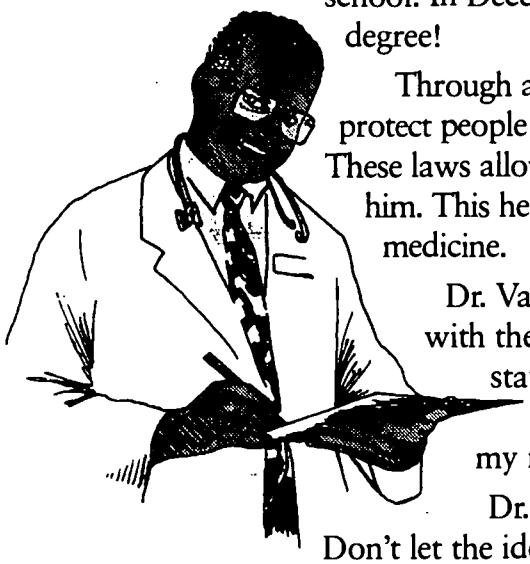
In 1967, when he was 20 years old, Garth Vaz came to the United States looking for a better life. He worked, he joined the Army, and he finally passed a test that was equal to a high school diploma. He dreamed of going on with more education. If only he could find the money, he would even go to medical school. What a dream!

He had a long way to go. He entered the University of Florida, but college courses were difficult for Garth, and he had to drop out. By this time he had a family to support—but in the back of his mind, he still longed to become a doctor.

Finally, Garth entered medical school at the University of Florida. In one of his classes, he heard about a "learning disability" called dyslexia (diz-LEK-see-uh)—a difference in brain functioning that can cause problems with reading and writing. As the professor described this difficulty, Garth Vaz recognized it as his own. Until then, he had thought his trouble was due to problems with his eyes as a child.

Garth still had trouble in medical school. He failed a class that required a lot of writing on medical charts, and he sometimes had trouble reading the questions with tricky wording. He had to leave and take another job.

But Garth Vaz would not give up. He took remedial courses and finally re-entered medical school. In December 1988, Garth Vaz's dream came true. He received his medical degree!



Through a physically handicapped friend, Garth had learned about laws that protect people with disabilities, so that they can achieve their highest potential. These laws allowed him extra time on exams and a person to read the the tests to him. This helped him to pass the exam to become certified in family practice medicine.

Dr. Vaz loves his work, but he will always feel challenged, just to keep up with the latest discoveries in medicine. When asked how he manages to stay on top of it all, he replied, "I always had a big fear of getting behind in my studies, so I got in the habit of staying ahead with my reading. This habit serves me well now."

Dr. Vaz gives this advice to others with dyslexia: "Pursue your goal. Don't let the idea of dyslexia stop you. Recognize your disability as a positive."

Famous People Who Had Difficulty Learning

Hans Christian Anderson - storyteller/author

Ann Bancroft - polar explorer

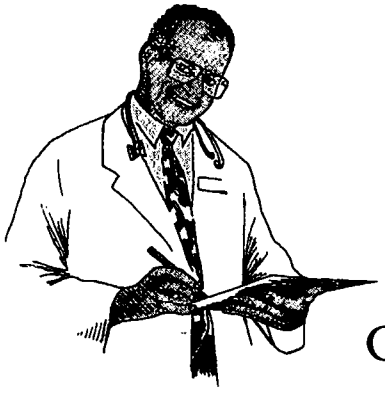
Ludwig von Beethoven - musician/composer

Werner Von Braun - engineer

Cher - actress/entertainer

Winston Churchill - Prime Minister of England

Tom Cruise - actor



Thomas Edison - inventor

Albert Einstein - scientist

Bruce Jenner - Olympic athlete

Greg Louganis - Olympic athlete

Louis Pasteur - scientist

George Patton - General in the United States Army

Nelson Rockefeller - Vice President of the United States

Auguste Rodin - sculptor

What's Your Story?

BRAINLINK BACKGROUND (for the teacher)

Review of Learning and Memory

The ability of the brain to learn and remember directs all of our activities, every day of our lives. Who we are, both as individuals and as a species, is shaped to a large degree by the remarkable properties of our brains, which enable us to retain and utilize information both from within and from the world around us.

Learning is the process of acquiring information or skills. We can learn in many ways, including by association, imitation and repetition. We even "soak things in" without trying to learn them.

Memory refers to the expression or recall of stored information or skills. There are at least two major types of memories. One deals with our "what" memories—facts, names, places and events. This is called *declarative* memory. The other is our "how to" memory—our memory of procedures, or how to do things, like walking, throwing a ball or tying a shoe. This is called *procedural* memory.

Memories are stored in the brain as changes in the synapses, or connections, among neurons in different places in the brain. The exact storage points of memories are not known. Some of the important structures for learning and memory, however, are the *cerebral cortex* (for declarative memories - "what") and the *cerebellum* (for procedural memories - "how").

Another part of the brain that is important to memory is the *hippocampus*. One hippocampus is located on each side of the brain within the temporal lobes (front part of the cerebrum). This seahorse-shaped group of cells is crucial for the formation of long-term memories about facts, experiences, people and places—our declarative memories.

Memories last for varying lengths of time. We remember some things for only a few seconds or minutes, and then they are forgotten. These are *short-term* memories. Other things, especially those which are repeated or are important to us, become stored as *long-term* memories. Long-term memories can last for a few hours to an entire lifetime.

Memory Stories

People, especially those in the same family or community, often tell each other stories about things they remember or have heard from the past. Long before history was written down with

ACTIVITY 7

CONCEPTS

- Declarative memory is our memory of what we have learned about people, facts and events.
- Procedural memory is our memory of how to do things.
- Different parts of the brain are involved in the processes of memory and learning.
- The collective memory of a people is known as its oral tradition.

OVERVIEW

Students review and apply concepts learned in Activities 1-6 by recalling and telling about a favorite memory and analyzing the processes of learning and memory involved.

SCIENCE & MATH SKILLS

Applying prior knowledge to a new situation

TIME

Preparation: 5 minutes
Class: 45 minutes

MATERIALS

- overhead transparency or copies of "My Memory" on page 38
- copies of "I Remember..." on page 39 (one per student)

The processes of memory and learning can be affected by differences in brain functioning, either inborn or acquired. Dyslexia and Alzheimer's disease are two examples of disorders that alter the abilities to learn and remember to varying degrees.

dates and places, storytellers related the lore passed down from their ancestors so that it was preserved from generation to generation. This way of passing on the collective memory of a people is referred to as *oral tradition*. Historical information sometimes is gathered and preserved more formally today through recorded interviews with participants in past events and ways of life. The preservation of people's memories when they tell their "stories" to interviewers is known as *oral history*.

Even though we might see pictures, videos or other records of things that happened in the past, nothing compares to hearing stories of what occurred in the words of someone who was there. It brings the past to life and links us closer to it and to persons remembering it. Although everyone remembers things differently, each account is valuable; different versions of the same event, all put together, can give a more complete and vivid picture of the past. Just writing down or recording our own memories now and looking at them later can let us re-experience events in our own lives and learn more about ourselves and our world.

LINKS

***Danger at Rocky River* Chapters:**

Remembering Rhymes
Grandpa's Victory

***Explorations*:**

Gray Matters (pages 2 and 3)
Use Your Brain - Promote Your Health (page 4)

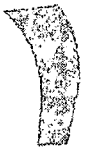
SET-UP

After introducing the concepts of oral tradition and oral history, have children work individually and in small groups to create their stories.

PROCEDURE

1. Explain to students that stories can be an important way of teaching, learning and remembering. For centuries, people have used stories to share and preserve the history and beliefs of their cultures, to learn about themselves and to give meaning to their lives. Tell students that they are going to be storytellers, sharing one of their own memories.

2. Ask each student to list five (three for younger children) of his or her favorite memories. Ask for examples from the class and discuss why the memories that were listed became part of their long-term memories.



3. Direct the students to think about and choose one of their memories to tell as a story to other members of a small group. Encourage them to include as many details as possible. Suggest beginning with phrases such as: I remember the first time..., the scariest time..., the funniest time..., when I learned to..., etc.

4. Tell the class that, as each student finishes his or her story, the group is to discuss possible answers to the questions on the "My Memory" sheet. Project the sheet, distribute copies or write the questions on the board, and talk about types of answers that would be appropriate for each question.

   You may want to encourage your students to think further by asking other questions such as, *How old are your memories? How accurate do you think they are, and why? Do family members or friends remember shared events differently?*

5. In groups of four, let each student share his or her memory story, with the group discussing answers to the memory questions for each story.

6. After the students have shared their stories, have each student independently complete the "I Remember..." sheet about his or her memory story. The sheet will contain a short summary of each student's story and answers to the questions about the memory.

7. After using them for assessment, save the "I Remember ..." sheets in each student's portfolio. Look at them again at the end of the school year, and suggest that the students save them to look at several years later. Tell them to ask themselves later, *Do I still remember this the same way, or do I now recall it differently? Why might that be?*

BRAIN JOGGING

Here are more ideas for you and your students to explore.

- Have each student make a drawing to illustrate his or her story and display the stories and finished artwork.
- Write a poem or song involving something you have learned about "learning and memory."
- Write and perform a play about the different ways in which we learn.
- Draw a picture or write a story about a person who has difficulty in learning or processing memories.

My Memory Questions

- Which kind of memory was it? ("how" or "what")
- Which senses were involved in making the memory? (vision, hearing, taste, smell, touch)
- Which type of learning was involved? (association, imitation, repetition, etc.)
- What helped it to be kept in long-term memory? (It may have been a surprise, something especially fun or exciting, practiced until learned, etc.)
- Which parts of the brain were used in forming and keeping this memory? (cerebrum, cerebellum, hippocampus, etc.)

My Memory

Let's review—

Ways of learning:
- association
- repetition (rehearsal)
- imitation

Types of memory:
- how (procedural)
- what (declarative)

- short-term
- long-term

Parts of the brain:
- cerebellum
- cerebral cortex
- hippocampus

Questions to ask and answer about your memory:

1. Which kind of memory was it? ("how" or "what")
2. Which senses were involved in making the memory? (seeing, smelling, etc.)
3. Which type of learning was involved? (association, imitation, repetition, etc.)
4. What helped it to be kept in long-term memory? (Was it exciting, scary, funny? Did you practice?)
5. Which parts of the brain were used in forming and keeping this memory?

I Remember

This is a summary of my story:

1. Which kind of memory was it? ("how" or "what") _____

2. Which senses were involved in making the memory? (seeing, smelling, etc.) _____

3. Which type of learning was involved? (association, imitation, repetition, etc.) _____

4. What helped it to be kept in long-term memory? (Was it exciting, scary, funny? Did you practice?)

5. Which parts of the brain were used in forming and keeping this memory? _____

Glossary

Alzheimer's disease - a disease, found especially in older adults, that damages or destroys cells of the central nervous system so that people can no longer remember or think normally

association - broad category of learning that involves forming mental connections among sensations, ideas, memories and movements

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

brainstem or brain stem - structure that connects the rest of the brain to the spinal cord and controls basic survival activities such as breathing, heartbeat, body temperature, and digestion

central nervous system - the part of the nervous system in vertebrates that consists of the brain and spinal cord

cerebellum - part of the brain located directly above the brainstem that controls the sense of balance and helps the muscles work together for learning and coordination of rote movements

cerebral cortex - the outermost component of the brain's cerebrum; controls our most advanced abilities, such as speech and reasoning

cerebrum - large rounded outer layer of brain where thinking and learning occur, sensory input is received and voluntary movement begins.

classical conditioning - type of learning by association in which a neutral stimulus (for example, a sound) is paired with a second stimulus that causes a response (for example, presence of food, leading to salivation)

declarative memory - knowledge or memory of past experiences, facts, people and events; stored in cerebral cortex

dyslexia - learning disorder caused by differences in brain function; can take many forms including difficulty with writing, reading, spelling, mathematics, speaking, listening, or remembering what is seen or heard

epilepsy - condition caused by sudden changes in the activity of neurons in the brain; affects a person's awareness and action, often with jerking movements of the body and limbs, for short periods of time

gyri - outward folds on the surface of the cerebral cortex

habituation - type of learning characterized by a decrease in the response to a stimulus; to be accustomed to something through continued exposure

hippocampus (hippocampi, plural) - a seahorse-shaped area of neurons in each temporal lobe of the brain; participates in the processing and formation of long-term memories

imitation - type of learning that involves observing someone else and copying his or her activity

learning - gaining knowledge or skills by instruction, study or experience; storage of information in the brain in a way that allows it to be recalled and applied

learning disability - any kind of disorder that makes it difficult to learn and process new information, especially relating to performance in school

long-term memory - more or less permanent storage of information and skills in memory; long-term memories can persist for a few hours up to an entire lifetime

memory - recall of knowledge or skills; information that people or animals have stored in their brains over time

nerve cell - neuron; a cell of the nervous system that conducts a signal from one part of the body to another

nerve - a bundle of nerve fibers and associated cells

nervous system - brain, spinal cord and nerves in the body

neuron - a cell of the nervous system that conducts a signal from one part of the body to another

neuroscience - branch of science related to study of th nervous system

oral history - documentation of past events through story telling from generation to generation

procedural memory - knowledge of "how" to do things, stored in the cerebellum

repetition - element of many learning processes that involves doing something over and over

sensitization - type of learning in which continued exposure to a stimulus leads to an increase in the response

sense - (1) function of the body by which one is made aware of the world outside, as sight, hearing, touch, smell or taste, or of conditions inside the body, as pain or hunger; (2) a feeling or awareness; (3) to become aware of

sensory - relating or pertaining to the senses

sensory neuron - type of nervous system cell that transmits impulses from a sense organ or receptor toward the central nervous system

short-term memory - an early stage in the processing of information in the brain, during which information is held for a short period of time (several minutes or less); some of the information held in short-term memory is lost, other information is processed further so that eventually it is held in long-term memory

stimulus - an agent that influences the activity of sensory neurons or any other kind of cell

synapse - tiny gap between the axon of one neuron and the cell body or dendrite of another neuron across which messages are transmitted chemically or electrically

temporal lobe - one of four lobes in the two hemispheres of the cerebrum; located on the sides of the brain and containing the hippocampi

BrainLink® Adventures

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THE READING LINK

Reading activities to use with

DANGER AT ROCKY RIVER

The NeuroExplorers in

A Memorable Misadventure

BrainLink® : Memory and Learning

The Reading Links have been created as ready-to-use reading and writing activities that are directly related to BrainLink adventure stories. They are not intended to represent a comprehensive reading program. The activities are related to reading objectives common to many curricula and cover a range of grade and ability levels. Teachers may wish to select from these activities those that are most appropriate for their own students.

Prepared by
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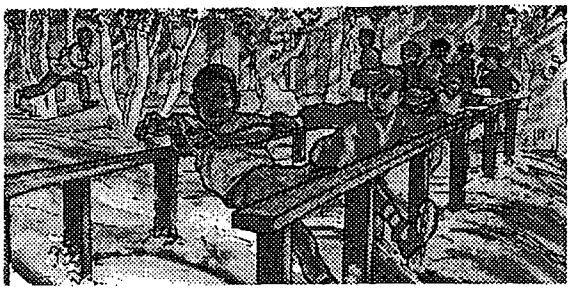
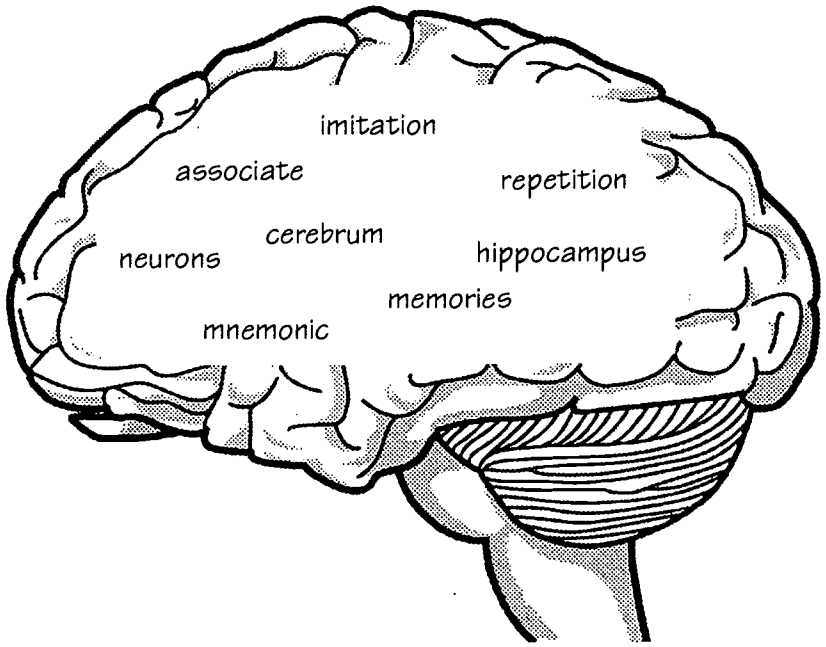
Houston, Texas
2000



Word Meanings

Each of the sentences below is missing a word. Choose the word in the brain that best completes each sentence, and write it in the space provided. (Not all of the words are used in the sentences!)



1. Memories are stored as connections among _____ in the brain.

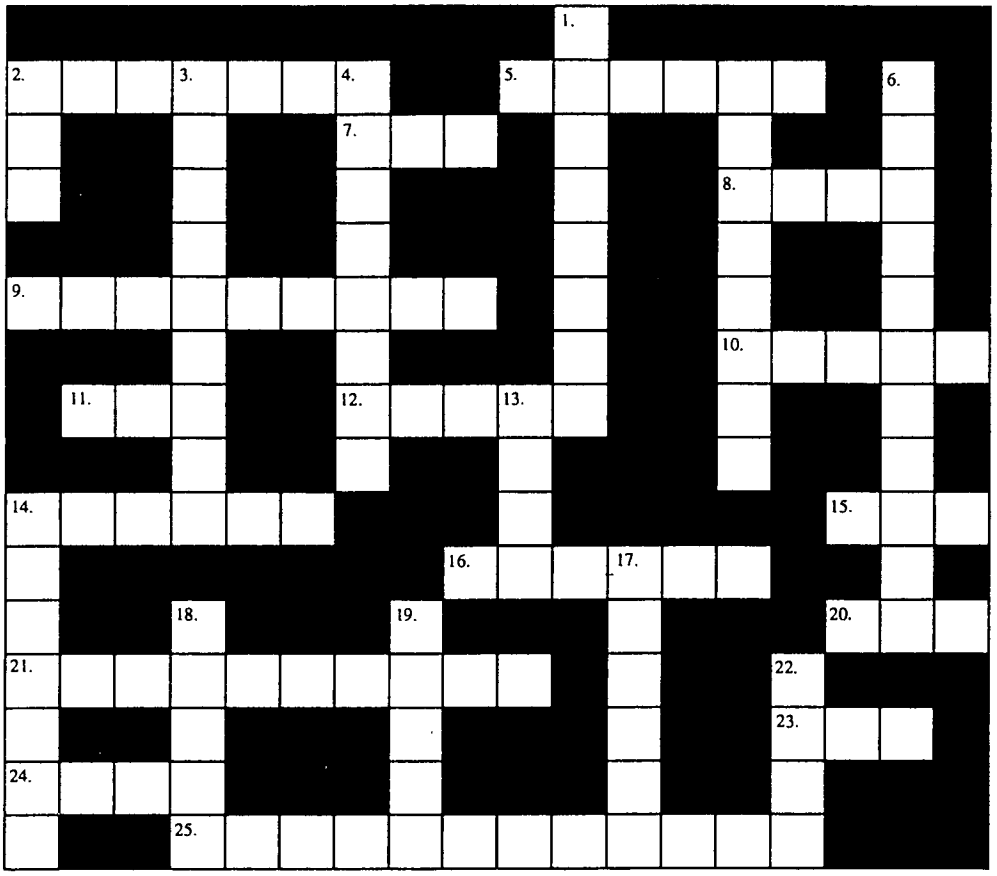
2. _____, or doing something over and over, is one way to make a long-lasting memory.

3. When you watch your Dad hit a tennis ball and copy his movements, you are learning by _____.

4. The _____, a small part of the brain that is shaped like a seahorse, is very important to memory and learning.

5. Ivan Pavlov's dogs learned to _____, or connect, the sound of a bell with being fed.

A Crossword to Exercise Your Memory



ACROSS

2. Tiny gap between axon of one neuron and dendrite of another neuron
5. Information that is stored in the brain over time
7. Mr. Miller writes notes to himself on this
8. The NeuroExplorers have an adventure when they visit _____' Grandfather.
9. Mr. Miller lives in _____ Gardens Retirement Center.
10. Command center of the body
11. The NeuroExplorers are saved when Mr. Miller helps them find this
12. All the bones of the head
14. Put away
15. Lakeisha likes to do this when she plays chess
16. A cell of the nervous system that conducts signals
20. Number of hippocampi on each side of the brain
21. A way of learning something by doing it over and over
23. When Max found his Grandfather, he gave him one of these
24. B.J. felt this when the dog leaped at her
25. A branch of science related to the study of the nervous system

DOWN

1. The _____ cortex is the outermost layer of the brain's cerebrum.
2. Max felt this way when he learned about his Grandfather's illness
3. Person who first described a memory disease that affects older people
4. Condition brought about by sudden changes in the activity of neurons in the brain, often with jerking movements of the body and limbs
6. Way of learning by making connections
14. He warned the NeuroExplorers about floods near Rocky River
17. To stop working any more, usually when someone is older
18. When you gain new knowledge or a skill, you _____ it.
19. In the mnemonic for remembering a seahorse-shaped part of the brain, this animal takes a dive
22. Isley II lost one of these in the river

Details/Supporting Ideas

A. What facts do you remember after reading *Danger at Rocky River*? Mark whether each of these statements is True (T) or False (F).

_____ Learning by association is learning by making connections.

_____ Memories of what we have learned about people and things are processed in the cerebellum.

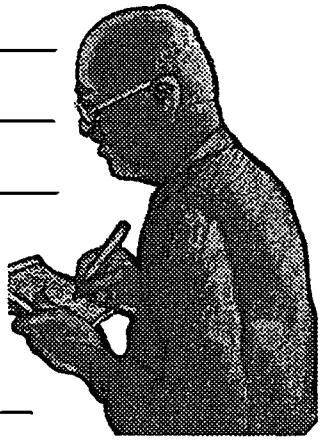
_____ Each person has two hippocampi.

_____ Repetition is important for making memories of procedures and movements.

_____ People with Alzheimer's disease suddenly can't remember anything at all.

_____ Memories associated with disagreeable experiences can be very strong.

B. Your friend Thomas has never heard of Alzheimer's disease. What could you tell him about it? Explain what you have learned about Alzheimer's disease to your friend. For example, what is Alzheimer's disease like? Where did its name come from? What causes it? How can relatives and friends help people with this disease? Write down what you would tell Thomas.



C. Pretend you are Lakeisha, writing a letter to your Aunt Jane who works in a nursing home. Your trip to Riverbend Gardens was your first visit to a retirement home, and you want to tell your aunt all about it.

Describe Riverbend Gardens to her, telling as many details as you can. Tell her whether it was like you had expected it would be, or not. Mention the things that were going on there, what you did there, and how you felt about it.

Dear Aunt Jane,

Sequence of Events

Which of the events below happened LAST in the story? Write 4 next to it. Then number the other events (1, 2, 3) to show the order in which they happened.

_____ Max's grandfather shocked everyone by reaching down and picking up a snake with his bare hands.

_____ Vince went back to Riverbend Gardens to get a pair of binoculars for bird watching.

_____ As B.J. tapped out a "hippo camp" rhyme with her drumsticks, a dog growled and leapt toward her.

_____ The sheriff told the NeuroExplorers about heavy rains to the north and warned them to stay away from the lowlands around Rocky River.

Main Idea

Look at the yellow box at the top of page 8. Which sentence below best tells the main idea of this Science Box? Fill in the circle by your answer.

- O Several areas of the brain are important for processing memories.
- O Memories of what we have experienced or learned are processed through the hippocampus.
- O This group of neurons, deep inside the brain, is shaped somewhat like a sea horse.
- O When the hippocampi are diseased or damaged, it is not always possible to learn new things and remember them.

Look at the yellow box on page 12. Which sentence below best tells the main idea of this Science Box? Fill in the circle by your answer.

- O Memories associated with disagreeable experiences often are very strong.
- O Blue jays, for example, learn to avoid Monarch butterflies after trying to eat just one.
- O Monarch butterflies taste extremely bad.
- O After the first experience, a jay will never try to eat a Monarch butterfly ever again!

Read pages 15–16 in *Danger at Rocky River*. Which of the following sentences best states the main idea of that chapter?

- O Everyone looked at Max and listened quietly to his story.
- O Two years ago, Max's Grandpa started having trouble with his memory and was diagnosed with Alzheimer's disease.
- O Max is worried and afraid, because his Grandpa has Alzheimer's disease and is unable to remember things any more.
- O Because he has trouble remembering, Max's Grandpa had to move to a place where someone takes care of him all the time.

Cause and Effect

Why did Isley I think the snake in his dream was poisonous?

Why did Pavlov growl and leap at B.J.?

Why was Max afraid to visit his Grandpa?

Why did Grandpa Miller get lost?

Why was Grandpa Miller able to lead the NeuroExplorers back to Riverbend Gardens?

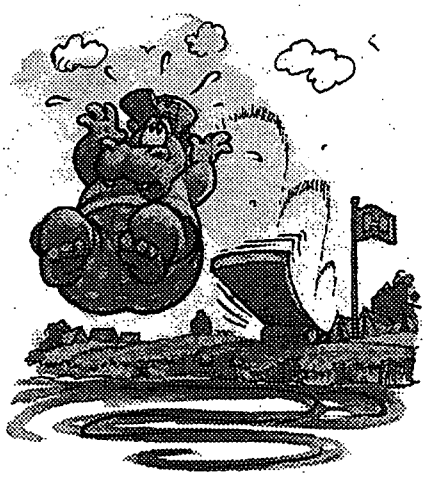
Summary of a Selection

Re-read the chapter called "Water Power" on pages 23–25. Think about what happened to Isley II and his friends in that chapter. Write a short descriptive summary.

Predicting Future Outcomes

Do you think the NeuroExplorers will go back to Riverbend Gardens again? Why or why not?

Think about how *Danger at Rocky River* ended. Can you imagine a different ending? Write a new possible ending of your own.



Inference/Generalization/Drawing Conclusions

A. When Isley II finally came out of the flooding river, scratched up and out of breath, he said, "What a ride! Man, those are some rapids . . . . You guys ought to try it!" Why do you think he said that? Write down all the possible reasons you can.

_____

_____

_____

_____

_____

B. Based on the story, *Danger at Rocky River*, decide whether each of these sentences is True or False. Mark T or F on the line by each sentence. If you decide a sentence is false, rewrite it below to make it a true statement.

_____ The markings on snakes often can be a quick clue to whether they are poisonous or not.

_____ People who are not good memorizers will never be able to remember lists of things.

_____ Animals can be conditioned to react in certain ways for their whole lives to things that happened to them long ago.

_____ People who live in places like Riverbend Gardens are very unhappy.

_____ It does not help people with Alzheimer's disease to write things down.

_____ Max would have made a big mistake if he had not dared to go to see his Grandpa.

Point of View/Fact-Opinion

Tell whether the following statements are fact or opinion (Write F or O):

_____ Isley I had a ridiculous nightmare.

_____ Hippocampus is a very hard word to remember.

_____ The hippocampus is very important for learning and memory.

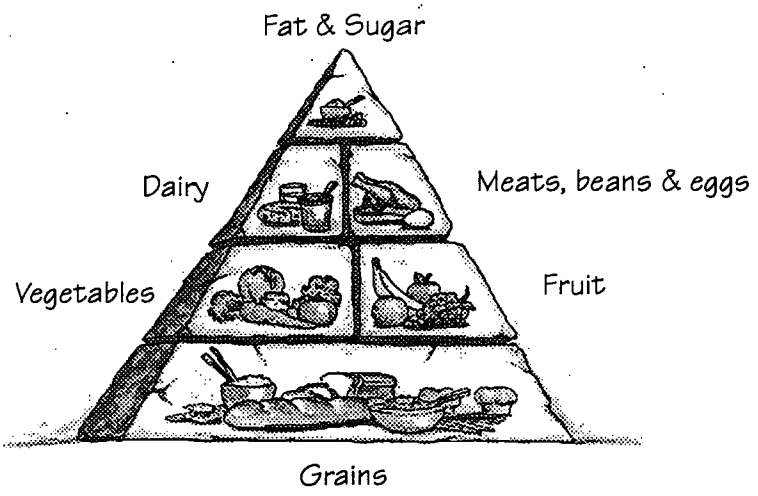
_____ Lakeisha should have been able to beat Mr. Plotsky at chess.

_____ Mr. Miller couldn't always remember people's names.

Food for Thought

Some of us are able to remember the nine planets in order or the colors of the rainbow by using a memory aid. Create your own mnemonic device to add the food pyramid to your long term memory. What words, sentence or rhyme can you create to help you remember all the food groups?

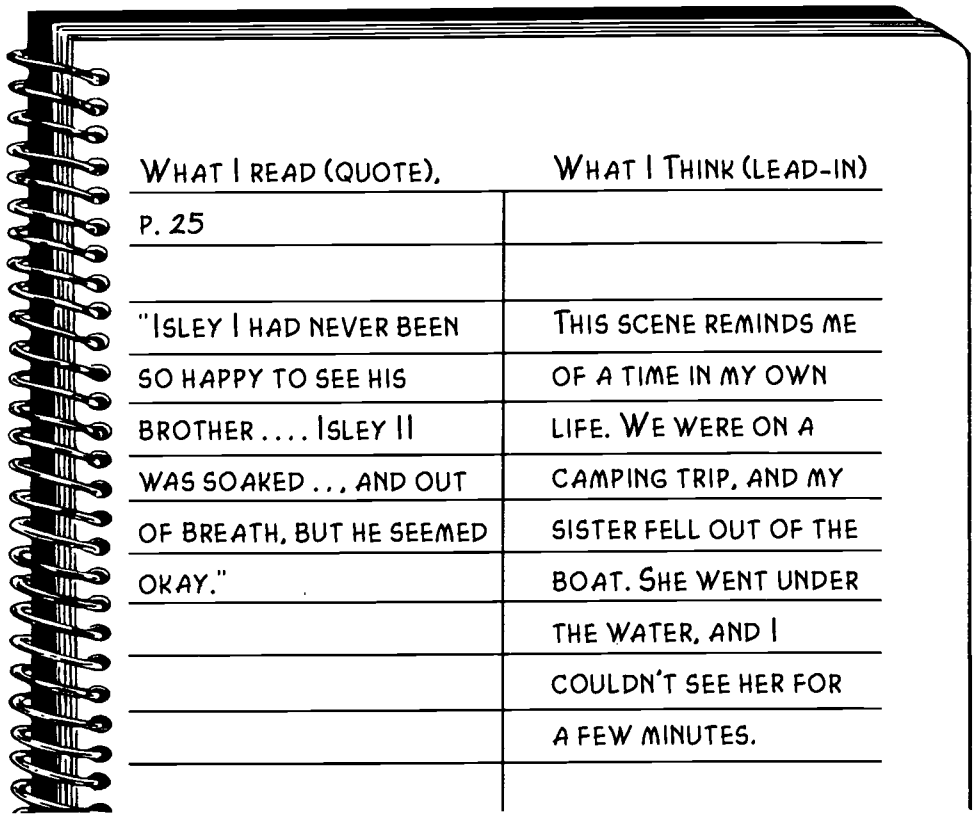
Can you even find a way to remember the numbers of servings from each group? Write and explain your mnemonic below.



Related Writing: Thinking About What I Read

Make a Double Entry Journal: Copy a passage from the story on the left side of your journal or notebook page, and write your reactions on the right side. Journal entries can be done every day and then brought to discussion groups.

Example



WHAT I READ (QUOTE).	WHAT I THINK (LEAD-IN)
P. 25	
"ISLEY I HAD NEVER BEEN	THIS SCENE REMINDS ME
SO HAPPY TO SEE HIS	OF A TIME IN MY OWN
BROTHER .... ISLEY II	LIFE. WE WERE ON A
WAS SOAKED ... AND OUT	CAMPING TRIP, AND MY
OF BREATH, BUT HE SEEMED	SISTER FELL OUT OF THE
OKAY."	BOAT. SHE WENT UNDER
	THE WATER, AND I
	COULDN'T SEE HER FOR
	A FEW MINUTES.

Other possible lead-ins to use for your journal reactions are:

a. This character reminds me of myself because . . . .

b. I wonder what this means . . . .

c. This scene reminds me of a similar scene in _____ because . . . .

d. I think this setting is important because . . . .

e. I think the relationship between _____ and _____ is interesting because . . . .

f. This situation reminds me of a similar situation in my own life. It happened when . . . .

g. Here's what I think will happen next . . . .

h. I'm confused about . . . .

i. A question I would like to ask these characters right now is . . . .

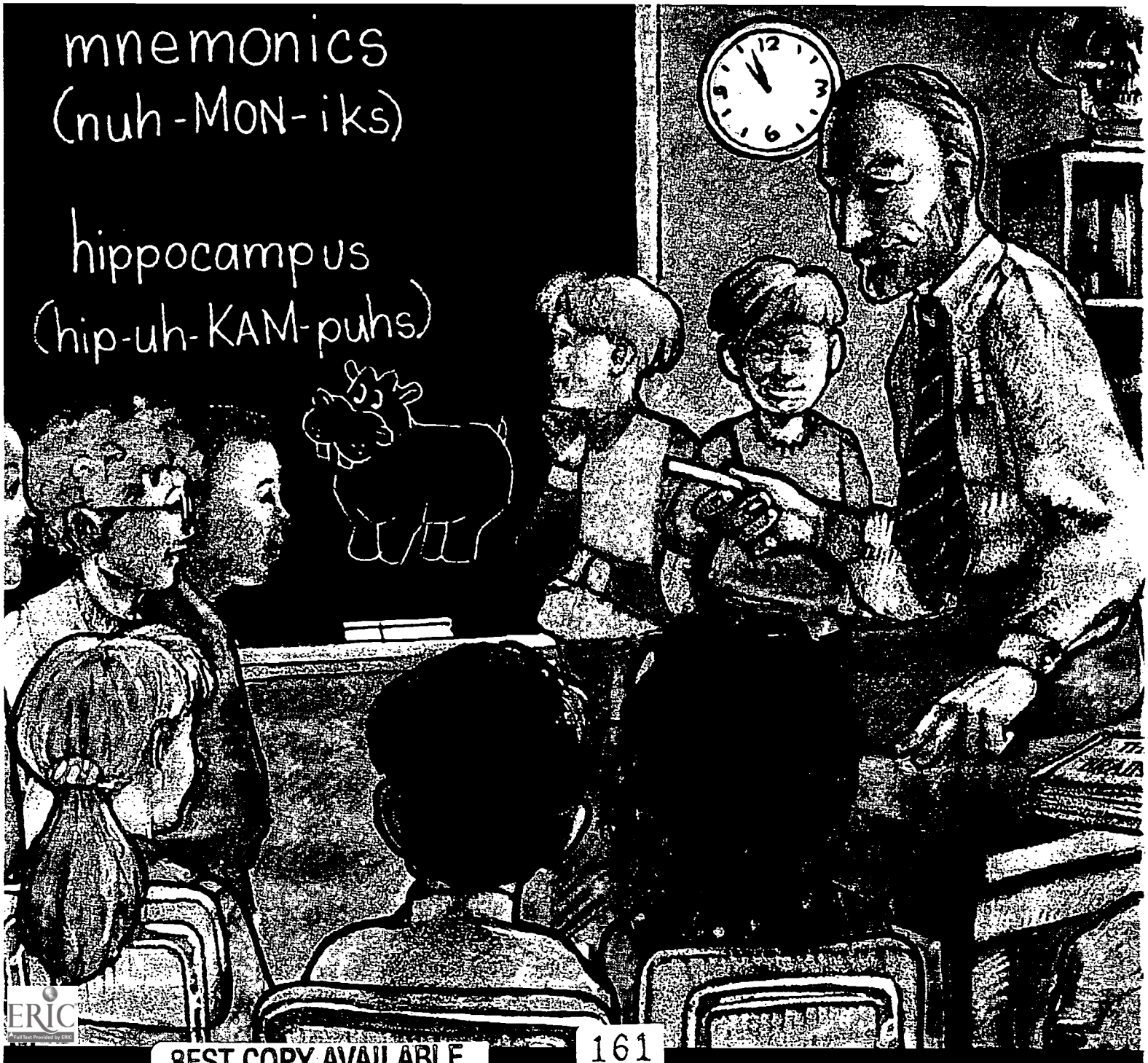
j. This part is realistic/unrealistic because . . . .

BrainLink MEMORY & LEARNING

EXPLORATIONS

FOR CHILDREN AND ADULTS

The NeuroExplorers Club spent the morning with Professor Ottzinger in his office. They are learning about the brain and how learning and memory work. They decided to begin by investigating their own memories. **Turn to the bottom of page 3 to see if you can help them!**



GRAY MATTERS

What are Learning and Memory?

We learn new things and remember old ones every day of our lives. **Learning** is the process of gaining new information. **Memory** is the system our brain uses to hold on to information and to get it back when we need it. All the facts we know, our knowledge of how to do things and our ability to make sense of what is going on around us depend on learning and memory.

Every time we learn something new, tiny changes take place in the connections inside our brains. What changes are made and what we learn depends on everything we see, hear, smell, taste, and touch–our experiences.

How do We Learn?

We learn from our experiences in many different ways. Our brains are programmed to help us learn some of the things that we need to know. For example, infants are born with the ability to learn any human language. The language a baby learns depends upon which language he hears the people around him speaking.

One way of learning is by copying what we see or hear. This is called learning by **imitation**. Young children learn to open a door or to brush their teeth by watching those things being done by someone else.

Learning also takes place as we make connections between daily experiences. For instance, your dog may notice that every time you take his leash out, he gets to take a walk. His brain makes a connection between the leash and a walk. Soon he gets excited and goes to the door whenever he hears the rattle of his leash. This is an example of learning by **association**.

Often we must learn by **repetition**–doing or saying something over and over until it stays in our memory. This is the way you learn to tie your shoes, to throw a baseball well or to recite a poem.

Sometimes we don't even know that we are learning. It's likely that you can sing a song or recite a commercial simply because you have heard it many times on TV, even though you never have tried to memorize it. Learning and memory are happening all the time!

How Long do Memories Last?

Some of our memories last for only a short time. Have you ever forgotten a telephone number right after making your call? This brief kind of memory, called **short-term memory**, is what you remember only as long as you are paying attention.

Some of the things we remember are saved as **long-term memory**. Things that are important to us may be placed in "permanent storage." This usually involves repetition or rehearsal. Long-term memories can last from a few hours to a lifetime. We often have to practice what we want to learn from songs in music class, to the multiplication tables in mathematics, to making free throws on the basketball court. Long-term memories also can be made instantly when you experience something very exciting or frightening, like your first roller coaster ride or a most embarrassing moment. What are some of your most vivid memories from a long time ago?

Are All Memories the Same?

Our "memory banks" hold a record of our past experiences. They include **what** we have learned about people, events, and facts of the world. These kinds of memories are processed through pathways in the **cerebral cortex**, the thinking part of the brain. By thinking about them, we can recall them. (This is called our declarative memory.)

We also have memories of **how** to do things, like riding a bike or playing a video game. Most of our "how-to" (or procedural) knowledge has improved with practice and become almost automatic. The **cerebellum** is especially important for remembering procedures. We don't have to think about these memories to use them.

How are Memories Formed?

Sensory receptors in our eyes, ears, nose, mouth and skin provide most of the information for learning and memory. Signals are sent to different areas of the cerebral cortex. The information is stored as memory through lasting changes in the physical and chemical connections between neurons in the brain. Sometimes signals are ignored, and the information is not remembered.

One small part of the brain, the **hippocampus**, is especially important in forming new memories. This is where new information is processed for short-term and then, perhaps, long-term storage. When the hippocampus doesn't work well, people have trouble forming new memories of events and facts, even though they still can remember things that happened a long time ago. They even can learn new motor skills and solve puzzles ... but they can't remember doing it. The hippocampus is a handy little part of the brain!

Where are Memories Stored?

Neuroscientists still do not know exactly where all of our memories are stored. Certainly, some memories are stored in the cerebral cortex, but several different areas of the brain may be involved. This is one of the many things left to be discovered by "neuro-explorers" of the future!

BRAIN FLASH

Just after birth, some baby birds learn to identify and follow the most noticeable large moving object around them. This usually is their mother or father, but sometimes it can be another animal or even a person! This kind of learning is called *imprinting*.

BRAIN FLASH

The curved shape of the *hippocampus* reminded early neuroscientists of a seahorse. In fact, hippocampus means "seahorse" in Greek. You have a hippocampus in each half of your brain.

Activities from page 1

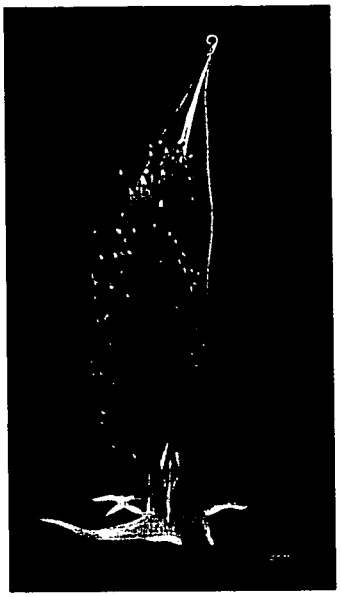
What Did The NeuroExplorers See In Professor Ottzinger's Office?

When the NeuroExplorers left Professor Ottzinger, they tried to remember everything they had seen in his office. ***Without looking back at the front page,*** what can you remember about the picture? Write a list of all the details you can remember.

Now go back and study the front page for 3 minutes. ***Then*** turn to the back page and try to answer the "Questions to Test Your Visual Memory" at the bottom of the page.

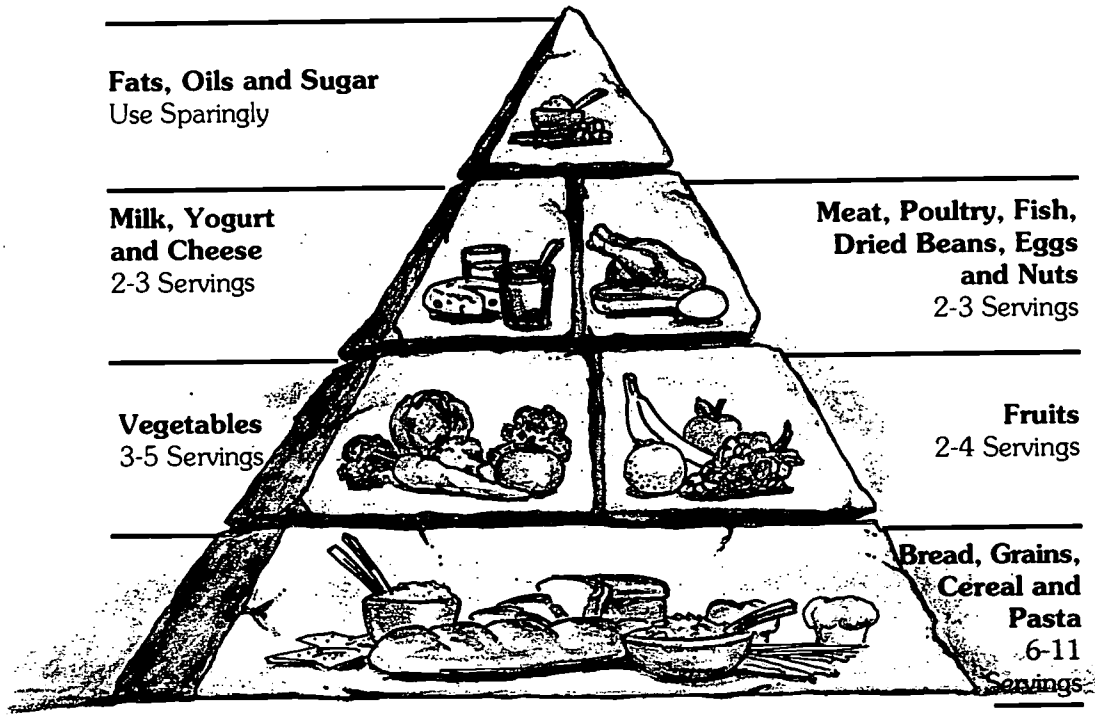
For learning and memory to take place, many different parts of your brain must be working together properly. Did you ever wonder how neuroscientists find out which parts of the brain are working when you read or speak, or try to learn or remember something? One way is through laboratory studies. Most laboratory studies on the brain are done with animals other than humans. Many different kinds of animals are used in experiments that give us important information about how the brain works.

One little animal, the sea slug *(Hermissenda)*, has such a simple nervous system that it is easy for scientists to see the neuron pathways used as the animal learns. These animals can be "trained" to move in certain ways when they see a light. With billions fewer cells to observe than in humans, scientists can actually see the physical, chemical and electrical changes that take place in a *Hermissenda's* nervous system when it learns. Information from these and other animal studies helps scientists understand how the human nervous system works. This knowledge then helps physicians to treat human patients whose brains have been damaged or changed by disease or accident.



Hermissenda photo by Dr. T. Crow, Univ. Texas Medical School, Houston

Use Your Brain — Promote Your Health



Food For Thought
(recommended daily servings)

One of the best ways to keep your brain in top form is to eat a varied diet that follows the food pyramid shown here. The foods you eat can affect the way your brain works. This is especially important at breakfast time.

A good basic breakfast, consisting of fruit or juice, milk or other protein and cereal or bread provides your brain with the nutrients it needs to learn and remember during a busy morning at school.

Try keeping a journal of the breakfasts that you and other members of your family eat during the next week. Is everyone getting enough brain food?

MEMORY POWER

Do you think you could memorize a string of 26 letters? Sounds hard? Actually, it's something you've already done. Most of us learned to say the letters of the alphabet in order by singing the "alphabet song." Using rhythm or rhyme to help remember something is one way that you can "boost" your memory power.

Memory boosters like this are called **mnemonics**. Another good example is using a phrase or word to remember a longer list. For example, the word **HOMES** helps us remember the names of the five Great Lakes — **H**uron, **O**ntario, **M**ichigan, **E**rie and **S**uperior.

You can even create a picture in your mind to help remember a difficult word or phrase. Imagining a hippopotamus at camp, for example, is a mnemonic to help remember the word, hippocampus.

Can you think of any other mnemonics that you already use? Try creating one of your own to help you remember everything that you need to bring to school in the morning.

BRAIN FLASH

Often we become so used to hearing, seeing or feeling something that we learn not to notice it. For example, do you pay attention to the feeling of your clothes on your skin or to everyday sounds at home or in the classroom? "Getting used to" the things around us is a kind of learning called *habituation*.

BRAIN FLASH

People and other animals know how to do certain things by *instinct*. This kind of knowledge is "wired" into the nervous system at birth—like a baby's knowing how to smile at its mother or a bird's knowing how to build a nest. Everything else must be learned.

Inventor Thomas Edison, scientists Albert Einstein and Louis Pasteur, the composer Ludwig von Beethoven, and fairy tale writer Hans Christian Andersen ...

What did all of these famous people have in common? Like 10% of the people in the U. S. today, they all had "learning disabilities," which made it much more difficult for them to learn in school than it was for their classmates.

A kind of "learning disability" that gives many people trouble in school is called **dyslexia**. Dyslexia includes many problems in learning that result from differences in the "wiring" in some part of the brain. These differences may cause trouble with writing, reading, spelling, doing math, speaking, listening, or remembering what is seen or heard.

Here is an example to help you understand what it might be like for some people with dyslexia. Suppose that a boy named Jason saw or heard this sentence:

Two people went down to the edge of the potato field after dinner.

When he tried to write it down, it came out like this:

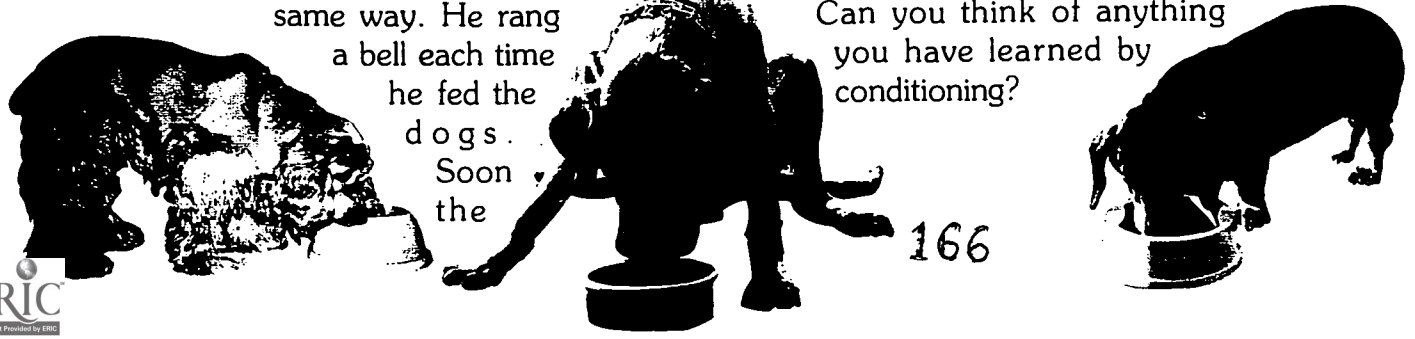
Tow pepl wnet bwon to the edg fo the ptato feld afrte biner.

This make-believe example may look silly to you, but it is something like what really happens. Imagine how frustrating it would be to Jason! Jason is smart. and he knows something is wrong. Other people can write the sentence, and he doesn't know why he cannot. To him, written words seem like riddles or codes for which he doesn't have the key. When he tries to write the sentence another time, it might look entirely different–but still not like the sentence that was given to him. You can see how difficult it would be for him to learn in school.

With special help, children like Jason *can* find ways to work around their learning differences. They still can do other things without any trouble, and one day they even could become as famous as Albert Einstein!

PAVLOV'S DOGS

Ivan Pavlov, an early scientist interested in how we learn, observed that dogs' mouths watered when they ate, smelled or saw food. He wondered if anything else could make dogs react the same way. He rang a bell each time he fed the dogs. Soon the dogs' brains made a connection between the bell and food, and their mouths watered whenever they heard the bell. even though no food was there. Pavlov called this kind of learning **conditioning**. Can you think of anything you have learned by conditioning?



THE FAR SIDE By GARY LARSON

"Mr. Osborne, may I be excused? My brain is full."

THE NEURO SIDE

Have you ever tried to learn and remember so much that you felt like your brain must be full? Well, it may feel that way sometimes, but it doesn't really happen. Scientists tell us that our brains can hold more information than we will ever put into them, even though we learn new things every day of our lives.

When we feel like we just can't learn any more, it probably means that we are tired and don't want to pay attention any longer. Can you think of some things you can do to keep from getting tired at school, so that you will be able to keep learning more and more? Nobody's brain ever gets "full"!

Careers for Neuro-Explorers: Neuroscientist

Would you like to be able to figure out why some people get diseases like Alzheimer's disease, or how to prevent or cure them? Neuroscientists are neuro-explorers who work in laboratories to find out the "hows" and "whys" of the nervous system. They are looking for ways to cure diseases or to heal damage to the brain, the spinal cord and the nerves.

Neuro-Explorer:
Dane Chetkovich, Ph.D.
Medical Student
Baylor College of Medicine
Houston, Texas

Dr. Chetkovich, what do you do?

I am a neuroscientist, but I'm also training to become a physician. As a medical doctor, I will be able to treat patients who have neurological diseases, and as a neuroscientist I will do research, hoping to find better ways to prevent, treat or cure these illnesses.

What do you find the most fun or most interesting about your work?

I'm fascinated with the wonders of the brain and nervous system. The idea of working with people who have problems and trying to find out why they got sick and how to make them better is very exciting. It's also fun for me to visit classrooms and share science with young students.

What advice do you have for future neuroscientists?

Be creative! Be original, and always keep your eyes and your mind open.

Editor's note: Dr. Chetkovich also likes writing for children. He is the author of *Danger at Rocky River*, the NeuroExplorers adventure story that goes with this edition of *Explorations in Neuroscience*.

Look at the picture on the front page once again. The Isley twins are under the clock in Professor Ottzinger's office. Now that you have an image of them in your memory, can you find them in the picture below? Can you find a brain, a skull, a neuron?

Many different kinds of learning are taking place in this picture. How many can you identify?

QUESTIONS TO TEST YOUR VISUAL MEMORY

After studying the picture on the front page for 3 minutes, turn this page around and see what you have remembered.

- How many people are in the picture?
- What color is the professor's tie?
- What is in the professor's pocket?
- What is the name of the book on the table?
- What is on top of the book shelves?
- Where is the dog?
- What is on the blackboard?
- What time is it?

How did you go about trying to remember things in the picture? Did you use any special tricks *(mnemonics)* to help you remember?

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