Dorothy Hinshaw Patent (b. 1940) was born in Minnesota. As a child, Patent loved animals and being outdoors, spending much of her time exploring the woods near her home. Her love of animals led her to study animals when she went to college. After college, Patent worked as a scientist for several years. Then she decided to start writing nature books for children so she could share her love of the natural world with others. Patent has now published over 100 books for children and young adults.

from
How Smart Are Animals?
Science Writing by Dorothy Hinshaw Patent

SETTING A PURPOSE As you read, focus on the distinct characteristics that indicate intelligence and how scientists try to discover these traits in animals.

How Smart Is Smart?
The blizzard came on suddenly, with no warning. Eleven-year-old Andrea Anderson was outside near her home when the storm struck. The sixty- to eighty-mile-an-hour winds drove her into a snowdrift, and the snow quickly covered her up to her waist. Unable to get out, she screamed desperately for help. Through the swirling wind, Villa, a year-old Newfoundland dog\(^1\) belonging to Andrea's neighbors, heard her cries. Villa had always been content to stay inside her dog run, but now she leapt over the five-foot fence and rushed to Andrea's side. First she licked the girl, then began circling around her,

\(^1\) Newfoundland dog (nōˈfən-lənd): a large strong dog bred in Newfoundland, Canada, and having a thick, usually black coat.
packing down the snow with her paws. Next, Villa stood still as a statue in front of the girl with her paws on the packed snow. The dog waited until Andrea grabbed her, then strained forward, pulling the girl from the drift. As the storm raged around them, Villa led the way back to Andrea’s home.

Villa won the Ken-L Ration Dog Hero of the Year award in 1983 for her bravery, loyalty, and intelligence. Her feat was truly impressive—understanding that Andrea needed help and performing the tasks necessary to save her. We can all admire Villa and envy Andrea for having such a loyal friend. But did Villa’s heroic behavior exhibit intelligence? Some scientists would say that, while Villa certainly is a wonderful animal, her behavior was unthinking, perhaps an instinctive holdover from the protective environment of the wolf pack, where the adult animals defend the pups against danger. After all, dogs evolved from wolves, which are highly social animals. They would say that Villa just acted, without really understanding the concept of danger or thinking about what she was doing. Up until the 1960s, this view of animals prevailed among scientists studying animal behavior. But nowadays, a variety of experiments and experiences with different creatures are showing that some animals have impressive mental abilities.

Do Animals Think?

If dogs might think, what about bees, rats, birds, cats, monkeys, and apes? How well do animals learn? How much of their experiences can they remember? Can they apply what they may have learned to new challenges in their lives? Are animals aware of the world around them? How might it be possible to learn about and evaluate the intelligence of different animals?

It is easy to confuse trainability with thinking. But just because an animal can learn to perform a trick doesn’t mean that it knows what it is doing. In the IQ Zoo in Hot Springs, Arkansas, for example, animals perform some amazing tasks. A cat turns on the lights and then plays the piano, while a duck strums on the guitar with its bill. Parrots ride tiny bicycles and slide around on roller skates. At John F. Kennedy Airport in New York, beagles work for the Food and Drug Administration, sniffing at luggage and signaling when they evolve (ɪ-vəlv) v. When animals and plants evolve, they gradually change and develop into different forms.
perceive drugs or illegal foods in the baggage. Dolphins and killer whales at marine parks perform some spectacular feats, and their behavior is often linked into a story line so that it appears they are acting roles, as humans would in a movie or play. These animals may seem to be behaving in an intelligent fashion, but they are just repeating behavior patterns they have been trained to perform for food rewards. The drug-sniffing beagle has no concept of drug illegality, and the duck doesn't understand or appreciate music. They aren't thinking and then deciding what to do.

Studying the intelligence of animals is very tricky. During the nineteenth and early twentieth centuries, people readily attributed human emotions and mental abilities to animals. Even learned scientists had great faith in animal minds—"An animal can think in a human way and can express human ideas in human language," said the respected Swiss psychiatrist² Gustav Wolff in the early 1900s.

Wolff's statement was inspired by Clever Hans, a horse that appeared to show remarkable intelligence. A retired schoolteacher trained Hans as he would a child, with blackboards, flash cards, number boards, and letter cards. After four years of training, Hans was ready to perform in public. When asked to solve a numerical problem, Hans would paw the answer with his hoof. He shook his head "yes" and "no," moved it "up" and "down," and turned it "right" or "left." Hans would show his "knowledge" of colors by picking up a rag of the appropriate shade with his teeth. Many scientists of the time came to watch Hans and tried to figure out how he performed his amazing feats; they went away impressed. Hans appeared to understand human language and to have mastered arithmetic.

Then Oskar Pfungst, a German experimental psychologist,³ uncovered Hans's secret by using what is now a standard scientific method—the double blind experiment.⁴

² psychiatrist (sī-kā'trō-tist): a doctor who deals with mental illness.
³ experimental psychologist (sī-kōl'jō-jist): a person trained to do research and testing that deals with the processes of the human mind and human behavior.
⁴ double blind experiment: an experiment in which neither the research subjects nor the scientists know the correct responses; both sides of the experiment are kept "in the dark" about the phenomena in question until the study ends.
When the horse was asked a question, no one in his presence knew the answer. Under these conditions, Clever Hans was no longer so “smart”; he couldn’t come up with the correct responses. By observing the horse and the audience when the answer was known, Pfungst discovered that Hans was very sensitive to the smallest movements of the people watching. They would lean ever so slightly forward until he had pawed the correct number of times, then relax. He watched for that sign of relief, then stopped pawing. His trainer unknowingly moved his head from side to side or up and down just enough for Hans to take a cue as to what to do. At the end of his investigation, Pfungst was able to prove his point. He stood in front of Hans without asking any question. He nodded his head slightly, and the horse began to tap his hoof. When Pfungst straightened his head, Hans stood at attention.

Ever since the embarrassment of Clever Hans, psychologists have been extremely wary of falling into the same trap. They are ready to call upon the “Clever Hans phenomenon” whenever an animal seems to be exhibiting intelligent behavior. Clever Hans taught psychology some important lessons, but the incident may also have made phenomenon (fə-ˈnə-men-ən) n. A phenomenon is an unusual or remarkable fact or event.
behavioral scientists\(^5\) too cautious about the mental abilities of animals.

Animals that are easy to train may also be very intelligent. Some of the most trainable creatures, such as dolphins, are also the most likely candidates for genuine animal thinking. But finding ways to get at animals' real mental capacity can be very difficult.

What Is Intelligence?

We humans recognize a "smart" person when we meet one; we know who is a "brain" and who is not. In school, we take IQ tests, which are supposed to give a numerical measure of our "intelligence." But these days, the whole concept of intelligence is being reevaluated. The older, standard IQ tests measure only a limited range of mental abilities, concentrating on mathematics and language skills. Creativity, which most people would agree is a critical element in the meaningful application of intelligence, has not traditionally been evaluated by such tests, and other important mental skills have also been ignored. But things are changing. Many scientists believe that dozens of different talents are a part of intelligence. In fact, more than a hundred factors of intelligence have been written about in scientific literature. Psychologists are now developing tests that measure intelligence more accurately and more broadly. The SOI (Structure of Intellect) test, for example, evaluates five main factors of intelligence: cognition (comprehension), memory, evaluation (judgment, planning, reasoning, and critical decision making), convergent production (solving problems where answers are known), and divergent production (solving problems creatively). Each of these is broken down further into many subcategories.

But what about animals? We can't hand them a pencil and paper and give them a test, and we can't ask them what they're thinking. We must find other ways of measuring their "smarts." And that's not the only problem. Since the lives of animals are so different from ours, we can't apply human standards to them. We must develop different ideas of what animal intelligence might be.

\(^5\) *behavioral scientists:* researchers who study human and animal behavior and mental processes.
The concept of intelligence was thought up by humans, and our thinking about it is tied up with our own human system of values. The things that are important to animals can be different from those that matter to humans. When studying animals, we must test them in situations that have meaning for their lives, not ours, and not just look to see how much they resemble us.

**Studying Animal Thought**

Many pitfalls await the scientist trying to interpret animals' behavior and make inferences about their intelligence. One is inconsistency. An animal might breeze through what we consider a difficult learning task and then fail when presented with what seems obvious to us. When an animal can't perform well, we don't know if it really cannot solve the problems put to it or if it just doesn't want to. Sometimes the difficulty lies in the perceptive abilities of the animals. The animal may have the mental ability and the desire to solve the problem but is unable to make the discriminations being asked of it. For example, a researcher using colored objects to compare learning in a cebus monkey and in a rhesus monkey first found that the rhesus scored much better than the cebus.

But rhesus monkeys have color vision that is essentially the same as ours, while the cebus's is significantly different. When the design of the experiment was changed and gray objects were substituted for the colored ones, the cebus monkeys actually did a little better than the rhesus.

Scientists studying animals in nature can run into difficulties in interpreting their results if they don't pay very close attention to what they see and hear. C. G. Beer of Rutgers University in New Jersey spent long hours studying laughing gull behavior. Early on, he interpreted what he called the "long call" as a signal that was the same for each bird and that was made on all occasions. But when he recorded a variety of long calls and played them back to the gulls, he noticed that the birds didn't always respond in the same way. There were differences in the calls that were hard for a human researcher to hear. Beer then realized that the long call was actually so individualized that it helped distinguish one bird from another! The more carefully he listened to the calls and

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6 **discriminations** (dɪ-skərɪ'mə-ˌnaʃənz): fine distinctions; small differences.
watched the gulls’ reactions to them, the more complexity and
variety he found in both the calls and the responses. From this
work Beer concluded: “We may often misunderstand what
animals are doing in social interaction because we fail to draw
our distinctions where the animals draw theirs.”

Measuring Animal Intelligence

Keeping all these concerns in mind, we can list some factors
of intelligence that might be measurable or observable in
animals—speed of learning, complexity of learned tasks,
ability to retrieve information from long-term memory, rule
learning, decision-making and problem-solving capacity,
counting aptitude, understanding of spatial relations, and
ability to learn by watching what others do. More advanced
signs of intelligence are tool manufacture and use, symbolic
communication, and ability to form mental concepts.

With such a list of capabilities that might be involved with
intelligence, it seems that scientists should be able to analyze
and compare the intelligence of animals. But it’s one thing to
decide to test intelligence and another to design experiments
that will measure it. You may read somewhere that rats,
for example, are smarter than pigeons. But finding ways to
compare the accomplishments of different species is virtually
impossible. Animals are just too varied in their physical
makeup and in their life styles. Scientists have found that
different kinds of animals learn better under different sorts
of conditions, so the same experiment usually can’t be used
meaningfully on a rat and a pigeon. In addition, some animals
have evolved special mental skills to deal with their particular
environments. They might appear especially intelligent on one
measure of brain power and very dull on another.

Dealing with wild animals presents new problems.
Laboratory pigeons and rats have been bred for many
generations in captivity. They are used to cages and to
humans, and large numbers are easy to acquire. Wild animals
may not perform well in the laboratory because they are afraid
or because the setting is so strange to them. And because
wild animals are often hard to come by, the experimenter
must usually work with only a small number of individuals.
Variations of “intelligence” from one individual to the next
can significantly affect the results. Primates—apes and
monkeys—are among the most intelligent animals, and apes

complexity
(kam-plek’s-tē) n.
Complexity is the
state of having many
different parts that
are connected in a
tangled or layered
way.

aptitude
(āp’t-i-tūd”) n.
An aptitude for
something is an
ability to easily and
quickly learn how to
do it.
seem closer to our idea of "smart" than monkeys. But a bright monkey may score as well on a test as an ape, while a dull one may be outclassed by a rat. For these reasons, behavioral scientists have realized that trying to compare the intelligence of different animals is a very challenging problem.

That doesn't mean, however, that trying to find out how animal minds function is not worth the effort. We can learn a great deal through studying how various kinds of animals solve problems and how they use their mental abilities to survive in their natural environments.

COLLABORATIVE DISCUSSION Can we know for certain whether an animal is showing intelligence, or whether it is simply highly trainable? What are some challenges scientists face in trying to determine animal intelligence? Discuss these questions with a small group. Be sure to cite evidence from the text.
Summarize Text

One way to check your understanding of what you are reading is to summarize it. When you summarize, you briefly restate in your own words the central ideas and important details of a text. A central idea is the most important point in a paragraph, section, or an entire work. Details are the support for the central idea.

This chart shows how to summarize the section "Measuring Animal Intelligence" in How Smart Are Animals? The central idea and a sample detail from each paragraph is recorded.

<table>
<thead>
<tr>
<th>Central Idea</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>There are many ways intelligence in animals could be measured. (lines 183-191)</td>
<td>Tests might include creating and using tools.</td>
</tr>
<tr>
<td>It is difficult to design useful tests and to compare different species. (lines 192-206)</td>
<td>An experiment used on a rat might not be useful for testing a pigeon.</td>
</tr>
<tr>
<td>Using wild animals in a lab is problematic. (lines 207-222)</td>
<td>They might not perform well in a strange setting.</td>
</tr>
</tbody>
</table>

Summary The section "Measuring Animal Intelligence" focuses on how animal intelligence might be tested. While there are many ways animal intelligence could be measured, testing is also problematic. Designing useful tests, comparing different species, and using wild animals are some of the challenges scientists face.

Generally, a summary is no more then one-third the length of the original text and includes just the facts—not your personal opinions. Try summarizing other sections of the selection as you analyze How Smart Are Animals?

Determine Author's Purpose

A writer's main reason for writing a text is called the author's purpose. The purpose may be to inform, entertain, persuade, or express thoughts and feelings. Most writers do not state their reason for writing. Their purpose is suggested through the information they present. A text can also have more than one purpose. To determine an author's purpose for writing, ask yourself these questions:

- Why is the writer telling me this?
- What does the writer want me to think about this topic?
Analyzing the Text

Cite Text Evidence  Support your responses with evidence from the text.

1. Infer  Reread lines 1–32 of *How Smart Are Animals*? What is the author's main purpose for writing? Explain how you know this.

2. Infer  The author introduces the topic with an **anecdote**, a short account of an event. Explain the author's purpose for including this event.

3. Evaluate  Review lines 33–110. Why does the author include the information about Clever Hans? Tell whether or not this example is effective and why.


5. Analyze  Review the main ideas the author discusses in each section of the excerpt. Tell whether or not the author answers the question "How smart are animals?" and explain why.

PERFORMANCE TASK

Writing Activity: Informative Essay  Write a one-page essay to explain the author's purpose in writing *How Smart Are Animals*?

- Review the selection. Note clues that help you determine the author's purpose in writing it.

- Summarize important ideas from the text. Cite relevant textual evidence to support your analysis, such as facts, definitions, details, and examples that help show the author's purpose.
Critical Vocabulary

<table>
<thead>
<tr>
<th>evolve</th>
<th>attribute</th>
<th>phenomenon</th>
</tr>
</thead>
<tbody>
<tr>
<td>inconsistency</td>
<td>complexity</td>
<td>aptitude</td>
</tr>
</tbody>
</table>

Practice and Apply  Answer each question.
1. Which Vocabulary word goes with complicated? Why?
2. Which Vocabulary word goes with irregular? Why?
3. Which Vocabulary word goes with change? Why?
4. Which Vocabulary word goes with event? Why?
5. Which Vocabulary word goes with assign? Why?
6. Which Vocabulary word goes with talent? Why?

Vocabulary Strategy: Verify Word Meaning

When you encounter an unfamiliar word in text, there are several ways you can verify, or check, its meaning. One way is to look for context clues in words, sentences, or paragraphs that surround the unfamiliar word. When you can't figure out the meaning of a word using context clues, you can look it up in a dictionary. Try to figure out the meaning of aptitude in this text.

Lin is so intelligent. She has an aptitude for solving difficult problems.

If you are unfamiliar with the meaning of the word aptitude, you can tell from the surrounding text that it has something to do with intelligence, even though the text doesn't state the word's exact meaning. When you consult a dictionary, you will find that aptitude means "an inherent ability, as for learning; a talent."

Practice and Apply  Complete the chart for the words listed. First, record context clues that give clues about each word's meaning. Consult a dictionary to verify the word's meaning and then write the definition.

<table>
<thead>
<tr>
<th>Word</th>
<th>Context Clues</th>
<th>Dictionary Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>feat</td>
<td>(lines 16–19)</td>
<td></td>
</tr>
<tr>
<td>wary</td>
<td>(lines 98–100)</td>
<td></td>
</tr>
<tr>
<td>virtually</td>
<td>(lines 196–199)</td>
<td></td>
</tr>
</tbody>
</table>
Language Conventions: Pronoun Number

A pronoun is a word used in the place of one or more nouns or pronouns. An antecedent is the noun or pronoun to which a pronoun refers. A pronoun must agree with its antecedent in number. In other words, if an antecedent is singular, you should use a singular pronoun. If an antecedent is plural, you should use a plural pronoun. Read this passage from How Smart Are Animals?

But what about animals? We can't hand them a pencil and paper and give them a test, and we can't ask them what they're thinking. We must find other ways of measuring their "smarts."

The antecedent, animals, is plural, so the pronouns them and their are also plural.

It is important to recognize and correct shifts in pronoun number. Read this sentence:

Marcus gave his dog some treats. His dog gobbled it up.

The pronoun it is singular, and does not match its plural antecedent, treats. This shift in number makes the sentence confusing. The correct pronoun to use is them.

Here's another example of a shift in pronoun number:

A scientist has to be careful when designing an experiment so that their results will be valid.

The pronoun their is plural, and does not match its antecedent, scientist, which is singular. The correct pronoun to use is his or her.

Practice and Apply  Correct the shift in pronoun number in each sentence. Some sentences have more than one mistake.

1. At the aquatic park, my uncle trains dolphins to retrieve objects. The dolphins learn quickly and bring the objects back to them.
2. The puppy ran around the park, howling, looking for their owner.
3. Mother blue jays are fiercely protective of her young and will chase away any predators that might threaten it.
4. Barry and Mitch groomed the horse, Princess, after they fed them. Princess whinnied softly as if to say goodnight to him.
5. Zoo visitors are enthusiastic when you see the big cats.