NEURO SCIENCE JOURNAL FOR TEENS

How can we test animals' intelligence?

LESSON PLAN

Introduction

This lesson explores the topic of intelligence in animals. Scientists who study animal cognition observe how animals solve different kinds of puzzles.

Learning Objectives

After the lesson, the students should be able to:

- Explain how animals use different thinking skills to navigate their habitats
- Explain why measuring animal intelligence is difficult
- Know the meaning of object permanence and theory of mind

Key Terms

- cognition
- behavior
- habitat
- object permanence
- Theory of Mind

Time Requirement

2 to 5 class periods depending on age and additional reading or writing assignments

Grade Level

Grades 2-8 (with adjustments)

Materials

- Cotton balls (at least 2 per student)
- Opaque cups (2-3 per pair of students)
- 1 larger opaque cup
- 1 tray large enough to fit 3 normal cups in a line
- Construction paper
- 2 jars or clear cups per pair of students, labeled "scientist" and "animal"
- Internet access and a projector to show photos, videos, and visualizations
- Printed reading assignment from **Science Journal for Kids**

Lesson Plan

1 GETTING STARTED

- Optional: show a short video, for example University of Auckland's **Causal Understanding of Water Displacement by a Crow** about New Caledonian crows.
- Start a conversation with students about intelligence in animals. What does it mean for an animal to be intelligent? What animal behaviors have surprised students with how perceptive (or how unperceptive) animals can be? How does intelligence help animals survive (finding food, protecting their young, avoiding predators)? Are there animals that survive without anything that we would call intelligence? (e.g., amoeba, jellyfish, zooplankton, clams, and other animals with no central nervous system)
- Scientists research animal intelligence for multiple reasons: some are interested in the behavior of a specific animal, others about why there are differences in animal brains, still others about how intelligence evolved.
- Measuring intelligence is not directly possible. There's a lot of disagreement about the definition of intelligence. Instead, scientists measure the ability of animals to complete tasks that measure specific cognitive abilities.
- Because primates like chimpanzees and orangutans are closely related to humans, many researchers have studied their cognitive abilities.
- In order for tests of cognitive ability to work, researchers need to make sure that it's possible for an animal to complete the tasks. (If you are studying dolphins, you can't use a test that requires the use of fingers.) And you must make it possible to do the test without explaining to the animal in words what they should do.

Duration: 25-35 minutes

2 READING ASSIGNMENT

- Individually or in groups, have the students read the article **How do ravens' thinking skills compare with apes'?** published in Science Journal for Kids. (For younger students, the teacher can read aloud and explain as they go along.)
- Discuss as a class. Why did the authors need to adjust the test? What other animals might need adjustments and why?
- Answer the assessment questions at the end of the article. (A teacher's key is available from the article's page online.)

Duration: 30-40 minutes

3 HANDS-ON ACTIVITY/GAME

Students will take turns playing the role of scientists and birds (or other animals, if desired). For younger children, the students playing the role of birds could make beaks out of construction paper. With the beak, they can peck to indicate their choices.

8 possible experiments are listed below. Choose 4 of the 8 experiments for the first group of scientists. This way, the "animals" will not know which tasks they are going to be doing.

- Set up an experiment station for each scientist-animal pair in the class. At each station, place a jar labeled "animal" and a jar labeled "scientist".
- Split the students into two groups of equal size.
- Explain to the students that each will have a turn to be in each role.
- Tell the animals that they can't talk to the scientists, and vice versa. They can tap things or otherwise use (animal-appropriate) body language to communicate. For example, they could tap the construction paper beak against a cup in order to choose that cup.
- Show the animals a cotton ball and tell them it's their favorite treat in the world. Their goal is to find a way to get the treat from the scientists.
- The scientists will each be given a different one of the experiment tasks. If possible, separate the two groups so that the tasks can be explained to the scientists without the animals hearing.
- Rotate the students through so that each scientist is paired with each animal, and each animal gets to try all the experiments.
- When an animal succeeds at the test, they may place one cotton ball into the "animal" jar at the experiment station. If the animal does not succeed, the scientist should place one cotton ball into the "scientist" jar.
- Once every animal has tried each of the experiments, privately tally the results of each experiment: how many times did the animal succeed? (How many cotton balls were in the "animal jar" compared to how many in the "scientist" jar?) If multiple scientists are running the same experiment, be sure to add them together. (This could be a good stopping point: resume the next class with the next experiments and a new group of scientists.)
- Then, split the students up again, reverse roles, and do it again, this time with the 4 remaining tasks.
- Bring the students back together for the discussion. Once again, privately tally the results of this set of experiments.

Duration: about 45 min (depending on class size and age)

EXPERIMENTS

1. Spatial memory.

Materials: 3 opaque cups, 2 cotton balls.

In full view of the animal, the scientist places 2 cotton balls under cups (so one cup is empty). The animal then has to find the cotton balls on the first try. If the empty cup is chosen, then the cotton ball is placed in the "scientist" jar (same for all remaining experiments).

2. Object permanence I.

Materials: 1 big opaque cup, 1 small opaque cup, 1 cotton ball.

In full view of the animal, the scientist places the cotton ball under the small cup. Then, the small cup is slid and quickly swapped with the large cup, ideally so the animal doesn't see the cotton ball in between. Finally the small cup is lifted and shown to be empty, then placed upside down on the table again. The animal must choose the larger cup (where the cotton ball is) on the first try.

3. Object permanence II.
Materials: 3 opaque cups, 1 cotton ball, 1 tray large enough for the three cups to be placed in a line.
The scientist shows the animal the cotton ball, places it under the cup, then turns the tray around. The animal must find the cotton ball on the first try.

4. Transposition.
Materials: 3 opaque cups, 1 cotton ball.

The scientist places the cotton ball under one of the cups while the animal is watching. Then, the scientist swaps two of the cups (like in the carnival game). The animal must find the ball on the first try. If there are enough students so multiple scientists are doing each experiment, have the scientists who are doing this test do different numbers of swaps from each other but always the same numbers each time.

5. Addition.
Materials: 3 opaque cups, 3 pieces of construction paper large enough to place over the cups as lids, 7 cotton balls.
The scientist places 2 cotton balls in the left cup, 1 in the middle cup, and 4 in the right cup, and covers all three cups. The scientist then uncovers the two outer cups and tilts them so that the animal can see for a few seconds. Then the covers are replaced and the cover of the middle cup is removed, and the contents shown to the animal. Then, the middle cup is poured into the left cup. The animal must choose the cup that has the most cotton balls in it (the right cup). The numbers in the cups can be varied as long as one cup will always have the most.

6. Gaze following.
Materials: 2 opaque cups, 1 cotton ball.
The scientist turns around and places the cotton ball into one cup so the animal doesn't see, and places the cups upside down on the table. Then, the scientist looks at the animal for a few seconds, then stares at the cup with the ball. Every 10 seconds or so, the scientist looks at the animal again then stares at the cup with the ball.

7. Pointing.
Materials: 2 opaque cups, 1 cotton ball.
The scientist turns around and places the cotton ball into one cup so the animal doesn't see, and places the cups upside down on the table. Then, the scientist points at the cup with the ball and waits for the animal to choose a cup.

8. Communicating intent.
Materials: 2 opaque cups, 1 cotton ball.
The scientist stands to the side looking away. Behind the scientist, the teacher or teacher's assistant places two cups on the ground, shows the animal the cotton ball, then places the cotton ball into a cup. The cups must be out of reach for the animal. The teacher then leaves and the scientist sits down in front of the animal and waits. Somehow the animal must get the attention of the scientist and direct them to get the treat.

Duration: about 30 min

4 DISCUSSION

- Without showing the results yet, ask the class which experiments were the easiest for the animals to do and which were the hardest.

  Show the tallies for each of the experiment tasks. Do the numbers support what the students felt?
- Talk about object permanence. Provide the definition, then ask: which tasks do you think measured object permanence? Describe how some animals, including infants less than a few months old, dogs, wolves, cats, and raccoons, don't reliably show signs of object permanence. Instead, they use trial-and-error (and smell) to find where objects went.
- Talk about the Theory of Mind (just a little bit: it's a huge topic with lots of interesting rabbit holes). The key point is that Theory of Mind is the ability to understand what another person or animal is feeling, thinking, and planning. Ask the students: do you think that animals living alone, like mountain lions, or in groups, like African lions, require more ability to interpret the behavior of others of their own species? Which experiments measured Theory of Mind?
- Do you think that the experiments were fair measures? What was hard for the "animals"?
- Discuss the difference between having the same skill at a set of tasks and having the same brain functions for completing those tasks. Bird brains have different construction than primates, so even if the scores are the same, the way the brain works is not necessarily the same.

Duration: about 30 min

5 CONSOLIDATION: WRITING ASSIGNMENT

- Review how different species of animals have different sets of challenges that they have to be able to meet in order to survive.
- Have the students choose an animal that they are interested in. (Could be a pet or a wild animal.)
- Have the students read about and then write about the kinds of challenges that that animal faces, and what kind of cognitive skills would assist in meeting those challenges.
- This could alternatively be assigned as homework.

Duration: 30 min or longer, depending on detail

Additional Resources

Auguste von Bayern. The Fascinating Intelligence of Birds. TEDxTUM.
https://youtu.be/3uLp0C6G__w

Lydia M Hopper & Sarah F. Brosnan (2012) Primate Cognition. Nature Education Knowledge.
https://www.nature.com/scitable/knowledge/library/primate-cognition-59751723/