Cognitive Maps in Animals

A central hypothesis of animal cognition is that many animals make use of cognitive maps—internal representations or codes—of the spatial relationships among objects in their surroundings. In a broad sense, most animals that migrate probably have some internal map of the way external objects are arranged.

The most extensive studies of cognitive maps have been made for animals exhibit seasonal migration, the regular back-and-forth movement of animals between two geographic areas at particular times of the year. Seasonal migration enables many species to access rich food resources throughout the year and to breed or winter in areas that favor survival. One long-distance traveler is the gray whale. During summer, these giant aquatic mammals feast on small, bottom-dwelling invertebrates that abound in northern oceans. In the autumn, they leave their northern feeding grounds and begin a long trip south along the North American coastline. Arriving in warm, shallow lagoons off Baja California (Mexico) in the winter months, they breed, and pregnant females give birth to young before migrating back north. The yearly round-trip, some 20,000 kilometers, is the longest for any mammal.

Among insects, the monarch butterfly has one of the most remarkable seasonal migrations. During winter, these insects decorate certain trees at the western tip of Cuba, in a few mountain valleys of central Mexico, and at a few sites along the California coast. All monarchs alive at the end of summer fly south to reach their wintering sites. With the onset of spring, monarchs mate at the wintering sites and begin migrating northward. As they arrive at summer destinations, they lay eggs and then die. Two or more generations are produced during the summer, repopulating the United States and southern Canada. With the approach of fall, the summer's last generation of monarchs flies south to the wintering grounds. They migrate as far as 4,000 kilometers and end up at a specific site, although they have not flown the route before.

Researchers have found that migrating animals stay on course by using a variety of environmental cues. Gray whales, for instance, seem to use coastal landmarks to pilot their way north and south. Migrating south in the autumn, they orient with the North American coastline on their left. Migrating north in the spring, they keep the coast on their right. Whale watchers sometimes see gray whales stick their heads straight up out of the water, perhaps to obtain a visual fix on land. Many birds migrate at night, navigating by the stars the way ancient human soldiers did. In contrast, monarch butterflies migrate during the day, resting in trees and bushes at night, genetic programming may enable them to use the Sun as a compass.

Navigating by the Sun or by stars requires an ability to keep track of compass direction. Many migrators also must have an internal timing mechanism that compensates for the continuous daily movement of Earth relative to celestial objects. The timing mechanism must also allow for the apparent change in position of celestial objects as the animal moves over its migration route. Almost nothing is known yet about the nature of these timing mechanisms. At least one night-migrating bird, the indigo bunting, seems to avoid the need for a timing mechanism by fixing on the North Star, the one bright star in northern skies that appears almost stationary. Researcher

have found that buntings learn a star map and fix on a stationary star when navigating at night.

Another interesting, and more or less open, question about migration is how birds continue navigating when the Sun or stars are obscured by clouds. These is strong evidence that some birds can orient to Earth's magnetic field. Magnetite, the iron-containing mineral once used by sailors as a crude compass, is probably involved in sensing the field. The mineral has been found in the heads of pigeons, in the abdomens of bees, and in certain bacteria that orient to a magnetic field. Future research may show that magnetic sensing is a widespread, important part of a complex navigation mechanism in many animals.

Paragraph 2

The most extensive studies of cognitive maps have been made for animals exhibit seasonal migration, the regular back-and-forth movement of animals between two geographic areas at particular times of the year. Seasonal migration enables many species to access rich food resources throughout the year and to breed or winter in areas that favor survival. One long-distance traveler is the gray whale. During summer, these giant aquatic mammals feast on small, bottom-dwelling invertebrates that abound in northern oceans. In the autumn, they leave their northern feeding grounds and begin a long trip south along the North American coastline. Arriving in warm, shallow lagoons off Baja California (Mexico) in the winter months, they breed, and pregnant females give birth to young before migrating back north. The yearly round-trip, some 20,000 kilometers, is the longest for any mammal.

1. The word "exhibit" in the passage is closet in meaning to

- ○ display
- ○ prefer
- ○ initiate
- ○ enjoy

2. Paragraph 2mentions all of the following as reasons that animals engage in seasonal migrations EXCEPT

- ○ to have access to rich food resources throughout the year
- ○ to spend the winter months in more favorable locations
- ○ to escape from other animals that feast on them
- ○ to reproduce in areas that make the survival of their young possible

Paragraph 2 is marked with an arrow [→].

Paragraph 3

Among insects, the monarch butterfly has one of the most remarkable seasonal migrations. During winter, these insects decorate certain trees at the western tip of Cuba, in a few mountain valleys of central Mexico, and at a few sites along the California coast. All monarchs alive at the end of summer fly south to reach their wintering sites. With the onset of spring, monarchs mate at the wintering sites and begin migrating northward. As they arrive at summer destinations, they lay eggs and then die. Two or more generations are produced during the summer, repopulating the United States and southern Canada. With the approach of fall, the summer's last generation of

monarchs flies south to the wintering grounds. They migrate as far as 4,000 kilometers and end up at a specific site, although they have not flown the route before.

3. According to paragraph 3, what is remarkable about the monarch butterfly's seasonal migrations?

○ The ability of monarchs born 4,000 kilometers away from the species' wintering sites to migrate to those sites
○ The ability to come back from wintering sites to summer destinations before laying eggs
○ The ability to locate wintering sites in various parts of North America
○ The ability to fly 4,000 kilometers without stopping to reach their wintering sites

Paragraph 3 is marked with an arrow [→].

Paragraph 4

Researchers have found that migrating animals stay on course by using a variety of environmental cues. Gray whales, for instance, seem to use coastal landmarks to pilot their way north and south. Migrating south in the autumn, they orient with the North American coastline on their left. Migrating north in the spring, they keep the coast on their right. Whale watchers sometimes see gray whales stick their heads straight up out of the water, perhaps to obtain a visual fix on land. Many birds migrate at night, navigating by the stars the way ancient human soldiers did. In contrast, monarch butterflies migrate during the day, resting in trees and bushes at night, genetic programming may enable them to use the Sun as a compass.

4. All of the following are mentioned in paragraph 4 as possible ways that animals stay on course during migration EXCEPT

○ observing the position of the coast relative to the direction of migration
○ observing the migration patterns of other animals
○ navigating by the stars
○ relying on their genetic programming

Paragraph 4 is marked with an arrow [→].

5. Which of the following is a "contrast" implied in paragraph 4?

○ Many birds, unlike monarchs, migrate over water.
○ Ancient sailors, unlike monarchs, were unable to navigate during the day.
○ Butterflies, unlike many birds, need to rest during migrations.
○ Monarchs, unlike many birds, are unable to navigate by the stars.

Paragraph 5

Navigating by the Sun or by stars requires an ability to keep track of compass direction. Many migrators also must have an internal timing mechanism that compensates for the continuous daily movement of Earth relative to celestial objects. The timing mechanism must also allow for the apparent change in position of celestial objects as the animal moves over its migration route. Almost nothing is known yet about the nature of these timing mechanisms. At least one night-migrating bird, the indigo bunting, seems to avoid the need for a timing mechanism by fixing on the North Star, the one bright star in northern skies that appears almost stationary. Researcher

have found that buntings learn a star map and fix on a stationary star when navigating at night.

6. The word "compensates for" in the passage is closet in meaning to
- ○ follows
- ○ recognizes
- ○ makes up for
- ○ is consistent with

7. Which of the following facts demonstrate that migrating birds need a "timing mechanism"?
- ○ Sometimes a migrating bird's internal compass does not function correctly.
- ○ The Sun is visible to migrating birds in the east in the morning, but in the west in the evening.
- ○ Most birds migrate either during the day or during the night, but not both.
- ○ Some stars, for example the North Star, do not appear to change position during a single night or even during the course of a long migration.

Paragraph 6

Another interesting, and more or less open, question about migration is how birds continue navigating when the Sun or stars are obscured by clouds. These is strong evidence that some birds can orient to Earth's magnetic field. Magnetite, the iron-containing mineral once used by sailors as a crude compass, is probably involved in sensing the field. The mineral has been found in the heads of pigeons, in the abdomens of bees, and in certain bacteria that orient to a magnetic field. Future research may show that magnetic sensing is a widespread, important part of a complex navigation mechanism in many animals.

8. The word "crude" in the passage is closet in meaning to
- ○ effective
- ○ temporary
- ○ reliable
- ○ primitive

9. The discussion of bird migration in paragraph 6 implies that
- ○ birds that can navigate by sensing Earth's magnetic field cannot navigate using the Sun or stars
- ○ pigeons can navigate when the Sun or stars are obscured by clouds
- ○ magnetite is likely to be part of the navigational system of only a few species of birds
- ○ birds' navigation using magnetite is not as accurate as their navigation based on the Sun or stars

Paragraph 6 is marked with an arrow [→].

Paragraph 2

The most extensive studies of cognitive maps have been made for animals exhibit seasonal migration, the regular back-and-forth movement of animals between two geographic areas at particular times of the year. ■ Seasonal migration enables many species to access rich food resources throughout the year and to breed or winter in areas that favor survival. ■ One long-distance traveler is the gray whale. ■ During summer, these giant aquatic mammals feast on small,

bottom-dwelling invertebrates that abound in northern oceans. ■In the autumn, they leave their northern feeding grounds and begin a long trip south along the North American coastline. Arriving in warm, shallow lagoons off Baja California (Mexico) in the winter months, they breed, and pregnant females give birth to young before migrating back north. The yearly round-trip, some 20,000 kilometers, is the longest for any mammal.

10. Look at the four squares [■] that indicate where the following sentence could be added to the passage.
    For a variety of animals, there are two clear purposes for this behavior.

    Where would the sentence best fit? Click on a square [■] to add the sentence to the passage.

11. Directions: An introductory sentence for a brief summary of the passage is provided below. Complete the summary by selecting the THREE answer choices that express the most important ideas in the passage. Some answer choices do not belong in the summary because they express ideas that are not presented in the passage or are minor ideas in the passage. **This question is worth 2 points.**

Drag your choices to the spaces where they belong. To review the passage, click on **View Text**.

Animals that migrate seasonally seem to have formed cognitive maps.

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-
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Answer Choices

Important aspects of animals' use of cognitive maps are not understood since the operation of cognitive timing mechanisms remains a mystery.

When navigating by the Sun and the stars, animals need to keep track of compass direction as well as adjust to other relative changes in Earth's movement and changes in the position of objects in the sky.

It has been suggested that under cloudy conditions, certain animals that navigate using the Sun and stars are able to sense Earth's magnetic field.

During seasonal migrations, animals use environmental signs, the Sun, and stars to navigate to wintering sites and back.

Some animals migrate during the day while others migrate during the night, depending on their genetic programming.

Future research is likely to show that magnetic sensing alone does not explain how birds navigate when objects in the sky are not visible.