



Module 8 : Spatial Reasoning

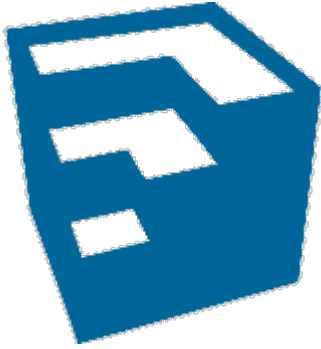
- Examples of spatial abilities in animals
- How animals navigate
- Scientific cognitive nomenclature
- Honing spatial abilities in pets

Module 8 will explore the definition of spatial reasoning, along with the following points:

- Examples of spatial abilities in animals
- How animals navigate
- Scientific cognitive nomenclature
- Honing spatial abilities in pets
- Timing and animals

Spatial Reasoning - 5m12s

8.1 Introduction



Spatial reasoning is a type of reasoning skill that suggests animals have a capacity to think about items in three dimensions, as well as infer conclusions about those objects from only a small amount of information.

The concept is best understood by examining a child learning the shape of an object. A child can use spatial reasoning to infer that a certain shape goes into a certain hole in a box because their ability to understand how the object looks when rotated allows the child to visualise the entire shape.

John Hopkins University takes this definition a bit further. Spatial reasoning is not only the capacity to understand an object's shape but also to understand its spatial relationship to other objects. A John Hopkins University study states this ability is distinguishable from other types of intelligence including verbal, reasoning and memory abilities. Furthermore, spatial reasoning is not a static trait, but one that takes several sub-skills to use, and these skills are developed throughout life. Spatial reasoning is not unique to humans.

In fact, one might argue that in certain instances, an animal's spatial ability is actually better than a human's. Spatial ability is applied to mathematics, engineering, natural sciences, meteorology, architecture, and economic forecasting. These are fields of studies humans have, but there are also animals capable of some architectural feats. Many animals in the animal kingdom are able to orient themselves in their environment as a way to return to their den, breeding grounds, feeding grounds or other places.

Let's examine birds' nests.

A bird's nest may not seem complicated in comparison to the Eiffel Tower; however, consider the architectural feat that it requires.

A bird has to choose a sturdy branch that is able to sustain the weight of the nest it will build using mud, sticks and other objects. The nest needs to support the weight of the eggs the bird will lay, plus the hatchlings through their growth periods. The branch also has to support all this weight. Much more goes into building the 3D object than you may consciously realise.

Beavers are another great example of architectural spatial reasoning.

Beavers build dams which are also their homes. The structure must block water, make their entrances secret, and provide a warm and dry location to raise their young. The right trees, the right lengths and the correct structure will all take much thought. Beavers with families also tend to work together to build these dams, so there is a social behaviour associated with the structure. In many cases the dams do not completely block the flow of water as they allow the river to still flow naturally, while the beaver still maintains a home. It takes strong spatial reasoning for the construction of a dam.

Returning to the example of birds: there are several bird species, such as geese, that fly south for the winter. These birds typically have a flight path they take to a specific destination. Instinctually,

behaviourists believe there is some sort of homing beacon that birds are genetically predisposed to, which allows them to visit a place they may never have been to as newly flying birds. Yet, there are times when these same birds have to take a different flight path due to adverse weather conditions, other objects in the sky, or other risks. Despite these changes in course for various reasons, the birds still find their way. It suggests that there are mapping elements in birds that may allow them to recognise certain structures or directions.

You may have heard pet stories, where a dog or cat was left behind at an old home and months later appears at the new home. There are other situations where pets have gone missing during human holiday trips but found their way home again. In other cases, some pets have moved with their families but disappear only to reappear back at the old home. This mapping ability would further support the concept of spatial reasoning in animals.

8.2 How do Animals Navigate?

Visual spatial skills are only a part of an animal's ability to use spatial reasoning.

Visual cues, such as paths, trees, bushes, homes and other objects, help animals find their way back.

Dolphins sense the shape of the ocean floor while wildebeest use the scent of rain to navigate their way. The uncanny ability of dogs, humpback whales and racing pigeons to find their way back home has stumped scientists since decades.

They seem to use a complex navigation system consistently, effectively and precisely at all times. Desert ants, for instance, use odour plumes or olfactory cues to navigate their way across sands.

Certain species of sea turtles, spiny lobsters, amphibians and birds seem to use the earth's magnetic field to orient themselves in the right direction. Bats use echo-location (vibrations from echoes) for spatial reasoning and sending objects around them.

Whales and dolphins also use echo location to navigate their way around predators and access feeding grounds. Animals that echo-location can sense objects much further away than is possible with visual spatial reasoning.

Shrews emit ultrasonic sound to locate prey and also to find their way across dark tunnels under snow.

Visual spatial skills are often combined with scent.

Scent as a way to block off territory and warn other animals that a certain perimeter is that animal's domain and crossing the border could lead to a fight. Male lions are like this. They will spray urine around the border of their territory and fight any male lion that dares to cross it. Scents like rubbing against a tree or urinating can all be markers to help ground animals navigate.

While certain visual objects are going to help the animal, it is more about following a trail with their nose.

Let's go back to a dog that is trained to locate an injured or missing person.

The dog is given a piece of clothing or other object with that person's scent on it. The dog will smell it and then start to smell around at the last place the person was seen. Following the scent with their nose the dog will continue until the trail goes cold or the person is found. Yet, after the person is found the dog can still return to the beginning, often without smelling the ground as often.

Some experiments show their scent is recognisable in the air, based on certain weather conditions. However, in rainy weather a dog can still make its way back to the beginning. This would suggest that a combination of scents and visual cues that they saw on the way to rescue the person is helping the animal find its way back.

Behaviourists have outlined an animal's ability to navigate into the following categories:

- Beacons
- Landmarks
- Dead reckoning
- Cognitive maps
- Detour behaviour
- Long-distance navigation or homing.

Beacons are generally considered nests, dens or homes that animals live in. Based on visual cues animals are able to see what their home looks like and locate it.

Landmarks are used in a similar manner to the way that humans use them. These are the visual objects an animal notes, based on what is in their vicinity.

Dead reckoning is the path integration or process of finding one's position from a known location.

Cognitive maps are built inside the mind, based on spatial reasoning of an animal's surroundings. From the map in their mind an animal is able to compute the distance they will need to travel in order to get to another location or back to their home.

Detour behaviour, as discussed above, is about understanding spatial environments so a different path to the same goal can be taken. Usually this occurs due to weather or the presence of a predator.

Long distance navigation or homing is about seasonal migration, as the examples above outlined. Behaviourists have hypothesized that spatial cognition exists as a skill for survival in many animals.

FACT



First-year birds often make their very first migration on their own. Somehow they can find their winter home despite never having seen it before, and return the following spring to where they were born.

Source: allaboutbirds.org

8.3 Honing Spatial Abilities in Pets



As humans, we understand it is possible for other people to increase their spatial abilities.

It takes a long process of learning and training to develop skills that take us beyond what was learned during infancy and early childhood.

However, it is possible to practice, train and learn new skills that enhance spatial reasoning.

We are not the only animals that have the ability to learn how to use basic spatial reasoning and enhance it.

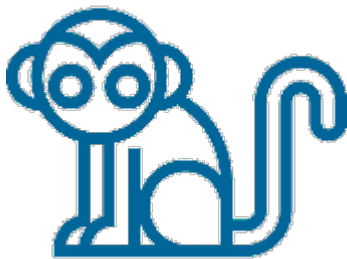
Chimps that paint are a good example. A chimp given a paint brush can be taught to paint, but moreover it can be taught to view the object and discern which end is to be used for painting. Chimps are also one of the animals that have a slightly better colour range than most pets. It is an evolutionary device that helps chimps distinguish between edible and non-edible plants. Not only can the chimp recognise the correct end of a paintbrush but they can distinguish between colours they want to use on the canvas. The distinguishing characteristics of the brush are found after the

chimp has time to examine the paintbrush and how it is used.

One dog owner has been working on behavioural studies with his dog. In this experiment the owner has several stuffed animals which he has associated with words. He will give a command to his dog to find a certain toy. The toy may be laid out or buried deep in a pile of other toys. In both instances the dog is able to find the toy the pet owner wants. The only way to find the toy is to be able to associate the word with the object the dog is looking for. This takes spatial reasoning rather than scent. If the dog was looking for scent - all objects would have his owner's scent and his scent. It would not be possible to distinguish between one toy or the other. There are visual cues based on the ability to discern shape with the word the owner has given as the command. Dogs are limited in the colour they see. This means it is the shape of the object versus visual colour cues.

It takes time for a pet owner to work on increasing an animal's natural spatial abilities. However, there are certain animals that can take cues and learn to differentiate objects. Dolphins are another example of spatial reasoning increasing with training. Dolphins can retrieve objects based on hand signals from a trainer. However, in order to associate the hand signal with the right objects, the dolphin has to be able to tell the difference in objects. If a ring and a ball are next to each other and the trainer wants the ring then the dolphin can be trained to bring the ring based on hand signals and spatial reasoning.

8.4 Spatial Reasoning and Problem Solving



Spatial reasoning is the beginning of problem solving skills.

Some problem solving skills are learned through observation. For example, a baby macaque will learn to use a rock to crack a crab shell in order to get to the meat. This same macaque can then use this natural technique and apply it to other objects. For instance, if the macaque finds a nut, it can use its spatial reasoning skills to figure out the nut can also be cracked like a crab.

Say an elephant trainer has hung food from a tree just out of the elephant's reach. The elephant is then given a choice of tools: a stick, a box and a ball. The elephant chooses the box. Based on spatial reasoning, the elephant has figured out that the box is flat and sturdy.

The elephant knows it can move the box under the tree, stand on it and reach with its trunk to get the food. It also knows the stick would block its nose, so it wouldn't be able to breathe. The elephant has also worked out that the ball is round and, therefore, not as good as the box.

Throughout the evolutionary process some instincts that animals have are learned. Otters are another good example. Otters will take shells and crack them by using rocks or other shells. Sea otters will first pound a shell to get it open a little and then lay on their backs to pry it open more. It suggests that long ago sea otters had to work out how to open shells to get at food and now through

instinct or training from an adult otter the new generations are able to recognise which type of shell or rock is best to open for the shells they like to eat from.

8.5 Timing and Animals

Animals are said to have an internal clock that times their life patterns, such as when to migrate.

The behaviour of most animals is linked to daylight and darkness.

This may be instinct or a pre-programmed concept; however, interval timing is certainly about spatial reasoning since an animal has to time their movements in order to survive, particularly if a predator has been spotted.

Summary

Spatial reasoning is not unique to humans.

For animals, it is a matter of survival, with some instincts already pre-programmed and other instincts that are learned from the previous generation. However, without the capacity to think and recognise the differences between objects, an animal would have difficulty surviving.

The ability to separate out certain objects based on shape or to understand the full shape of a 3D object without seeing the 'whole' can mean the difference between survival and death for several species in the wild.

Spatial reasoning can be used to help train pets, making it another good reason for pet owners to know the difference between a natural behaviour and one that can be conditioned.

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