

Hide & Seek Moon

Children use binoculars to search for small items that an astronaut lost while walking on the Moon. The Moon is pictured on a banner hanging a short distance away.

 15 minutes

 Drop-in

 1–4 children at a time



Content Learning Goals

- Children notice that binoculars make distant objects appear closer/bigger.
- Children begin to understand that binoculars help us see more detail in distant objects.

Science Practices

- Children **observe** changes in how objects appear (bigger/closer) when using binoculars.
- Children **use a tool** to better see the small images.

Materials

- Moon Banner
- Child-friendly binoculars*
- Small black & white images of items to tape to the Moon (page 7)
- Astronaut sign (page 8)

Optional:

- Photo of the Moon (page 9)
- Markers

SET-UP

- Hang the Moon banner on a wall.
- Cut out the pictures of the ten items the astronaut lost (page 7). Tape them to the Moon on the banner.
- Place a short table or bench with one or more sets of binoculars about 10–12 feet from the wall with nothing obstructing the view of the Moon. Try to choose a distance such that it is difficult to recognize the items with the unaided eye, but easy with the binoculars, keeping in mind young children have sharper eyesight than adults. The ideal distance will depend on the lighting in the room.
- For a drop-in program, place the astronaut sign (see page 8) on the table for parents to read to their children.

* We recommend using binoculars that are visually appealing to children, properly sized for their small faces, intuitive to use, and have quality optics for a clear view. At the time of publication, after trying many types of binoculars, we found that Kidnoculars by Geosafari Jr. met all of these criteria and were by far the easiest for very young children to see through. While they only give a 2x magnification, they are much easier for young eyes and hands to use.

ACTIVITY DESCRIPTION

1. Invite children to approach the table with binoculars and tell them that the astronaut in the picture lost some things on the Moon. Point to the distant picture of the Moon and ask them “Can you see any of her things? What do you see?” (Sometimes they can see a few with their unaided eyes.)
2. Invite children to help find the astronaut’s lost things. Some children may want to walk up to the picture of the Moon to get a closer look — remind them that we can’t go to Moon to find the objects. Ask them, “What could we use to help us look?” If the children are not sure, tell them about how astronomers use tools like binoculars and telescopes to get a better look at distant objects. Offer the binoculars and give them a minute to investigate how to use them. (Children may also be naturally drawn to the binoculars without any invitation or prompting.)
3. As the children practice using the binoculars, encourage them to first describe what they are observing through the binoculars (“What can you see? What does it look like?”). They may not describe differences in size, so follow up with asking them “How does it look different when you use the binoculars?” Encouraging children over 3 years to describe differences they notice when they look through the binoculars versus what they see with just their eyes is a good way to help them learn to make careful observations and explore the ways that tools can help us learn about the world.
4. Encourage the children to describe what they see on the Moon. If they did not describe differences before, such as objects looking larger or closer, you may want to ask them again once they find a specific object on the Moon. Older children may enjoy challenging themselves to find all ten items, whereas younger children may have fun just calling out the ones they find.
5. You may optionally offer the children a photograph of the Moon (page 9) and a marker, and suggest that they record their observations, marking the locations on the Moon where they locate the objects. They can either draw a picture of the object or mark the location with an X. This lets them practice their observation and data recording skills.
6. Ask the children “What other things might you want to look at with binoculars when you are outside?” Help them think about how they could see more detail on objects that they are interested in. Focus on things that are too far away to see clearly.



DEVELOPMENTALLY APPROPRIATE STRATEGIES

Binoculars are often a new tool for young children. Even those who have experience with binoculars may find it difficult to see through them. Help children gain confidence in their ability to use the binoculars to magnify distant objects by using the developmentally appropriate strategies below:

Provide Information about binoculars as a tool for magnifying distant objects (e.g., “*Binoculars are a tool that help people see things that they can’t see with only their eyes.*”)

Demonstrate how to hold the binoculars (e.g., “*If I want to see the objects on the Moon poster, I’ll look through the small lenses and point the binoculars toward the Moon.*”)

Ask questions/make statements that encourage children to describe what they are noticing (e.g., “*You’re looking at the Moon through the binoculars, tell me what you see.*”). Some children, particularly those younger than 4 years of age, may prefer to first explore and then discuss their observations (e.g., “*Let me know when you’re ready to talk about what you notice on the Moon.*”). Help children reflect on the difference between what they can see with their eyes alone and what they can see with binoculars (“*What did you notice on the Moon when you used the binoculars? Now use just your eyes. Do you notice a difference? How does the Moon look now?*”)

EXTENSIONS AND CONNECTIONS

- You might want to use your own pictures instead of the ones we provided. For example, you could print out pictures of characters from popular children's books and movies and ask children, "Who's hiding on the Moon? Will you help me find my friends on the Moon?" Children are delighted to see their favorite characters through the binoculars. You can use the pictures we provided as a guide for sizing yours. We recommend searching for "coloring" images, which are black and white line drawings that blend into the surface of the Moon yet are still easily recognizable through the binoculars.
- If children want to play the game more than once, you could let them change the position of the pictures on the Moon and challenge their friends or family members to find the objects in their new positions.
- Have children make and decorate their own "binoculars" out of two toilet paper tubes. At this age, it provides a focus for their observations and practice looking through two tubes. Encourage their identities as astronomers.
- If your museum has extra binoculars, allow a check-out so that families can take them around the museum and return them when done.

BACKGROUND INFORMATION

The following background information about the learning sciences and astronomy is intended for the educator who will facilitate the "Hide & Seek Moon" activity. The activity is a developmentally appropriate first step toward the children eventually understanding the concepts explained below, perhaps years later. We do not intend the educator to cover most of these concepts with the children during the activity. This information is provided to give the educator a good basic understanding of the scientific concepts that the activity is moving toward, and preparation to answer questions from very curious children or adults.

LEARNING SCIENCES: HOW CHILDREN UNDERSTAND SIZE AND DISTANCE

Interpreting Size and Distance

The Hide & Seek Moon activity is meant to help children begin to recognize the fact that far-away objects look smaller than they are, and to learn that we need tools like binoculars to help us to see objects that our eyes can't see on their own. This is a difficult concept for children at this age. In one study, 4-year-olds recognized more often than not that you would need to move an object closer to yourself to make it look bigger, but 3-year-olds' answers on this task were not different from chance¹. In another study, 5- and 6-year-old children consistently underestimated the size of an object that was 61 meters away, when asked to choose a comparison object of the same size². Older children (ages 7 to 10 years) were better at estimating the size of the far away object, but the age differences did not seem to result from changes in perceptual ability. Instead, errors in estimating size were correlated with cognitive ability to interpret the perceptual cues. For example, children (at any age) who were better at explaining why far away objects tend to look smaller, were the same children who did well at estimating size². Based on these findings, Granrud (2009) argues that children and adults misperceive the size of distant objects, but that once we understand this limitation, we can compensate for it when judging distance.

¹ Pillow, B., & Flavell, J. (1986). Young children's knowledge about visual perception: Projective size and shape. *Child Development*, 57, 125-135.

² Granrud, C. (2009). Development of size constancy in children: A test of the metacognitive theory. *Attention, Perception, and Psychophysics*, 71, 644-654.



Distinguishing Appearance from Reality

Preschool-aged children are still developing understanding of the links between appearance and reality, as well as between what we see and what we know. By age 3 years, children are very aware that we can know something about an object by seeing it, and that someone who can't see an object is not likely to know that it is there. For example, 4-year-olds can tell us that a puppet who looks in a box “knows” what object is there, but a puppet who hasn't looked doesn't know what's in the box³. However, preschool-aged children also overestimate the knowledge they can gain by viewing a small part of a picture⁴, for example thinking that looking through a tiny window to see a few lines of a drawing will be enough to tell them how big the whole drawing is. What this may mean for the Hide and Seek Moon activity is that once children can see the objects on the moon with binoculars, they are likely to think that their sibling standing next to them will see the objects too — even without binoculars. In fact, children might even claim that they have been able to see the objects all along! Once children at this age know something to be true, they often have difficulty remembering that they didn't used to know that. This is part of children's developing understanding of their own and others' minds — as important focus of children in the 3 to 5 age range⁵.

Figuring Out How Distance Affects Apparent Size

My Sky Tonight researcher Dr. Jennifer Jipson's study of preschoolers' conversations about astronomy further backs up some of the previous findings mentioned above. For example, many children could distinguish close from far-away objects, yet they were less likely to offer explanations for how they knew. When asked about how objects seemed to be changing in the book *Zoom*, which depicts the same scenes from varying distances, the teacher asked, “Are the animals getting smaller? How are they getting smaller?” Many children agreed that they were getting smaller, which is ambiguous as to whether they believed it was an actual change or an apparent change. One 4-year-old stated that “they just look smaller” and another 4-year-old explained, “because we move farther away and they get smaller.” As in the previous studies, some children in the preschool range will have clearer understanding of the link between size and distance, but many will be just working out how our perception of objects is related to how they really are.

ASTRONOMICAL SCIENCE BACKGROUND: THE TOOLS OF ASTRONOMY

What you're exploring determines what tools you'll need to explore it. Geologists have their rock hammers, chemists have their test tubes, and microbiologists have their microscopes. In astronomy, most of the things we explore are so far away and hard to reach that we depend on observing them from a distance. The vast majority of information we have about those distant astronomical objects is carried in the light that reaches us from them. Astronomers' main tools are ones that gather that light and bring it to a focus.

Binoculars are a great tool for young stargazers. They are easy to use, and generally a lot less expensive than a telescope. The trick to getting a closer look at something with binoculars is to first look at the object and then bring the binoculars up to your eyes. But how do they work? At the heart of binoculars are two lenses. The lens closest to the object is the objective, which gathers light and brings it to a focus. The lens closest to your eye is the eyepiece, which magnifies the image to make it appear closer.

You'll often see two numbers associated with binoculars, for example 7x50 (“seven by fifty”) or 8x25. The first number refers to the magnification and the second to the diameter of the objective lens in millimeters. The Kidnoculars that we recommend for this activity are 2x35, meaning they magnify two times, and have 35mm objective lenses.

There are two advantages to having a large objective lens: resolution and brightness. Resolution is the ability to distinguish small details of an object (for instance, is that bright spot one large star or two stars that are close together?).



³ Pillow, B. (1989). Early understanding of perception as a source of knowledge. *Journal of Experimental Child Psychology*, 47, 116-129.

⁴ Taylor, M. (1988). Conceptual perspective taking: Children's ability to distinguish what they know from what they see. *Child Development*, 59, 703-718.

⁵ Gopnik, A. (2009). *The Philosophical Baby: What Children's Minds Tell Us About Truth, Love, and the Meaning of Life*. NY: Farrar, Straus, & Giroux

Brightness is also important to consider, since the farther away an object is, the dimmer it looks. Having a larger lens is like having a bigger eye, capturing more light so objects look brighter.

Why do things look smaller / farther away when you look through binoculars backwards?

With the arrangement of the lenses in a pair of binoculars, you can either make a small area of a scene look bigger (looking the right way through them), or you can make a big area look small (looking through them backwards). If you've ever played with a zoom lens, you might have a feel for what is going on. When you zoom in, you are adjusting your camera's lens to have a long focal length. That means you are filling your view with just a small piece of the picture. That's the view that you get using binoculars in the way they were meant to be used. The objective lens has a long focal length to give you a close up view. When you zoom out with a camera, you are adjusting your camera's lens to have a short focal length. This gives a wide view, so you're seeing more, but everything is small. The eyepiece lens on binoculars has a short focal length, so when you turn the binoculars around and use that short focal length lens as the objective, you have zoomed out and everything looks smaller and farther away.

Telescopes are the next step up for astronomers. With even bigger lenses or mirrors to gather the light, even more wonders in the universe are revealed. Where you put your telescope can make a big difference in what you see. If you're in the middle of a city surrounded by lights, even the biggest telescopes won't be able to distinguish dim galaxies from the bright background light in the sky. For this reason, research telescopes are located far from cities under very dark skies. But it's not just lights that keep us from getting a good view, it's also our air! You've heard the childhood rhyme, "Twinkle, Twinkle, Little Star." It's the air in the Earth's atmosphere that makes the starlight twinkle, so the less of it that we have between our telescope and the star, the better. Astronomers put their telescopes up on a mountain where there's less of the atmosphere above them, and even out in space where there's no air to distort the light.



Short focal length (12mm)



Long focal length (135mm)



The Gemini telescope has a very large mirror, over 26 ft. in diameter, and it is located at an altitude of 4200 meters (close to 14,000 feet) at Mauna Kea, Hawaii.



The Hubble Space Telescope orbits the Earth, outside the distortion of the atmosphere, allowing it to take very high resolution images of distant astronomical objects. Its mirror is about 8 ft. in diameter.

Telescopes and binoculars are a great beginning to give our eyes a better view of the heavens, but astronomers don't stop there. Astronomers use different kinds of instruments on their telescopes to measure how bright the starlight is and even break it up into a rainbow of colors so they can figure out how hot a star is, what it's made of, how fast it's moving, and how far away it is.

Why are mirrors used instead of lenses in many telescopes?

Binoculars use lenses, but most telescopes use concave mirrors to gather and focus light, rather than lenses. We want our telescopes to collect as much light as possible. This is done by increasing the diameter of the collecting area (also

called the aperture). If the telescope uses a lens to collect light, the larger the aperture, the larger the lens must be. The rim of a lens is much thinner than the center. Lenses can only be supported around the rim since light must go through them. As the lens becomes larger, it becomes heavier and more difficult to mount. A very large lens will also begin to sag under its own weight, distorting the image. A telescope that uses a mirror to collect light can be designed so the mirror is fully supported across its entire expanse. This allows mirrors to be much larger than lenses, thereby allowing reflecting telescopes to collect much more light to detect the dimmer objects in the universe.

Can we see the flag that the astronauts left on the Moon?

No, this is a common misconception. You cannot actually see the flag on the Moon, even with a powerful telescope, even if it is on an orbiting satellite! Of course, we would not be able to use these tools, let alone binoculars, to find an astronaut's gloves, lunch, or teddy bear left behind on the Moon either, but this element of fantasy in this activity provides an entry point to encourage children's interest in trying a new tool.

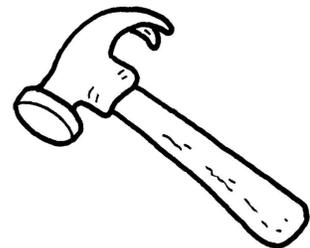


Further reading

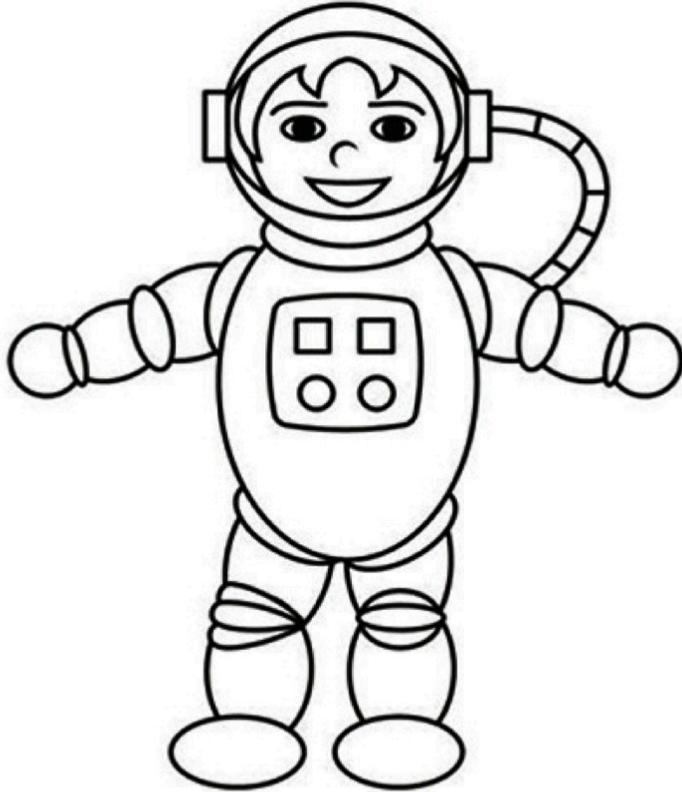
- For a guide to making astronomical observations and using binoculars with very young children, see “Toddlers at the Telescope” by Alice Enevoldsen in the July 2014 issue of *Sky & Telescope Magazine*.
- For more information about binoculars and a beginner's guide to choosing binoculars for astronomy, see: <http://www.universetoday.com/91259/beginners-guide-to-binoculars/>
- For more on the history of telescopes and how they are used in astronomy, see: <http://amazing-space.stsci.edu/resources/explorations/groundup/>



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Hello! Can you help me?
I dropped 10 of my things while
walking around on the Moon.
Can you use the binoculars to find them?



My Sky Tonight



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