Human Feet Are Strange

hhmi | BioInteractive

Activity
Educator Materials

OVERVIEW

The activity "Human Feet Are Strange" was developed to supplement the film *Great Transitions: The Origin of Humans*. In the film, starting at time mark 9:40 minutes, paleoanthropologist Dr. Tim White describes the Laetoli trackway, a set of preserved hominid footprints in Eastern Africa discovered in 1976. Fossils of the hominid species *Australopithecus afarensis* have been found near the Laetoli footprints. Since *A. afarensis* was the only hominid species known to be living in the area at the time, it is assumed that the footprints at Laetoli were made by *A. afarensis*.

Dr. White also says that, "human feet, we're all used to them, but they're really strange." What does he mean by that statement, and what is the significance of the Laetoli footprints? Students will explore these questions in this activity.

Students first study footprints made by themselves or their classmates. The prints are made by covering the soles of the feet with water-soluble paints and then walking on a 3 foot × 10 foot sheet of paper ("classroom trackway"). They are then asked to analyze the shape of their feet and the position of their toes, arches, and stride. Next, students make observations and draw inferences from an illustration of the 3.6-million-year-old trail of Laetoli footprints ("Laetoli trackway"), compare their own footprints with those of the Laetoli trail, and evaluate the evidence in support of the conclusion that the Laetoli footprints were made by a fully bipedal human ancestor. This activity ends with a summary activity, which students can complete as homework.

KEY CONCEPTS

- The fossil record provides a history of life on Earth and includes not only the fossilized bones of dead organisms but also trace fossils, such as footprints.
- Bipedalism, or walking primarily upright on two legs, is one of the traits that distinguish modern humans from all other modern primates.
- The observation of living organisms can provide insights into traits and behaviors of extinct species.

STUDENT LEARNING TARGETS

- Differentiate between observations and inferences.
- Develop inferences based on observations and other types of evidence.

PRIOR KNOWLEDGE

Students should be familiar with:

- the tree of life and that modern humans belong in the primate group, with modern chimpanzees as the closest living relatives
- a basic understanding of evolution, including the unifying theory that species descend, with modification, from other species
- the fossil record as a way of knowing about past events

MATERIALS

Materials are for a class of 24 students.

Part 1

- One handout per student, excluding the summary activity (Part 3), which you will hand out separately
- One 3 foot × 10 foot strip of white paper for the trackway
- Four or five plastic, 33-gallon trash bags to place under the trackway (optional, if the floor is carpeted)
- One roll of wide masking tape or duct tape
- Dark shade of washable finger paint or washable poster paint
- Four disposable aluminum baking pans large enough to fit a large foot
- Foam paintbrush (optional)
- Two basins of water for washing feet
- Paper towels for drying feet
- Four chairs (two at each end of the trackway)
- Meterstick
- Images of other animals' feet, including those of primates and great apes (optional)

Part 2

- 12 laminated copies of the 10-inch version of the Laetoli trackway (Flammer et al., 1998; Randak, 1998)

  Note: Instead of providing printed copies of the Laetoli trackway, you may want to project it for students to observe.
- A hi-res version of the entire trackway (Flammer et al., 1998; Randak, 1998) can be enlarged to 3 feet × 12 feet, printed, and laminated (optional)

Part 3

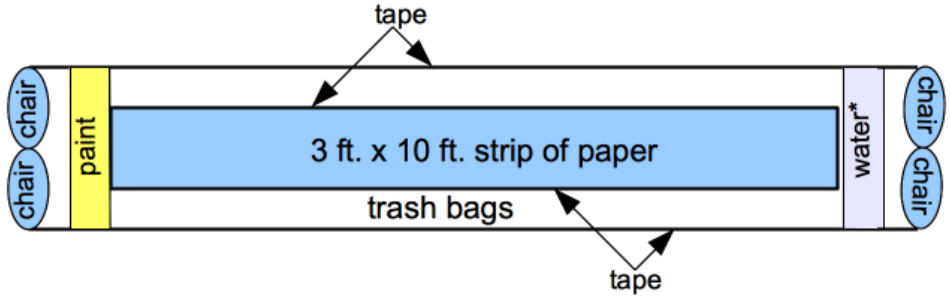
- One copy of the summary activity (Part 3) of the student worksheet per student

PROCEDURE

Part 1: Classroom Trackway

A. Setup can be done before class or with the assistance of students during class:

- If the floor is not carpeted, tape a 3 foot × 10 foot strip of paper to the floor. Use either wide masking tape or duct tape to securely hold the strip of paper. Any paint spills will easily wipe up. If the floor is carpeted, tape enough trash bags to the floor to form a protective layer under the strip of paper. The trash bags should extend beyond the paper as shown in Figure 1.
- Place two chairs at each end of the trackway.
- Place the aluminum pans and containers of paint so that they are easily accessible to the volunteers when seated.



*Note: Have the water and paper towels ready but do not slide the water basins into position until after the volunteers are seated.

Figure 1. Setup for Footprint Activity.

B. Introduce the activity:

- Distribute Parts 1 and 2 of the student handout. Then lead into the activity by telling students that in the film Great Transitions: The Origin of Humans, paleoanthropologist Dr. Tim White states that human feet are "strange" (**Part 1, question 1**). If you can, project some images of other animals' feet, including those of some primates and great apes. As you compare feet, ask students what they think Dr. White means.
- Write some of the ideas on the board. Next, tell students that they are going to make a trail of their own footprints for analysis.

C. Make the trackway:

- Ask for two volunteers. They must be willing to take off their shoes and socks and have the bottoms of their feet covered with paint. (Option: Divide the class into groups of three or four students and have each group make a set of tracks. Then compare all the sets the class made.)
- The paint can be applied in either of two ways. You should try them both before doing the activity in class. First, pour some paint into the aluminum pans.
  - Method 1: Ask the volunteers to dip their feet into their pans of paint. The entire bottoms of their feet should be covered with paint—including the arches and toes.
  - Method 2: Using a foam paintbrush, have a student assistant cover the bottoms of each volunteer's feet with paint.
- Request two students to help safely guide the volunteers as they walk down the pathway. **Caution!** Warn the students that the paint is slippery!
- With assistance from the guides, first one and then the other volunteer should step onto the strip of paper and walk to the opposite end. Tell the second volunteer to be careful not to step on the prints left by the first volunteer. The prints near the end will be faint.

D. Discuss observations and inferences:

- Let students observe the footprints and write down their observations (**Part 1, question 3**).
- Ask a volunteer to use a meterstick to determine how close together the feet are (horizontal distance) and how long the stride is (longitudinal distance).
- Ask whether students can infer where most of the weight was placed on the foot (i.e., on the heel or toward the toes, the big toe or the small toes, on the outside or down the middle) and if so, what observations are they basing this inference on. The paint is usually darker where more weight was placed on the foot.
- Record some of the observations on the board (**Part 1, question 3**). Students should also record the similarities and differences between the two sets of prints (**Part 1, question 4**).

  Discuss the difference between an observation, which involves using one or more of the five senses to collect data, and an inference, which is an assumption made from an observation. Ask your students to think about what inferences they could make about the height or age of the individuals who made these prints or how fast the individuals were walking, if your students had not seen the footprints being made. For example, ask these questions:

  - *Can you infer anything about the individuals' absolute or relative heights?*

  In general, the longer the stride, the longer the legs and the taller the individual.

  - *Can you infer whether they were walking or running?*

  In general, the stride length is longer when running, and the footprints usually show that more weight was placed on the ball of the foot.

- *Can you infer whether they are old or young?*

Differences in size can provide a clue as to whether the individual was a child or an adult, but a small adult could leave the same-sized prints as a larger child.

Students should record the consensus answers to these questions in the space provided on their handouts (Part 1, question 5). Ask students to identify some things they could not infer without seeing the footprints being made (Part 1, question 6).

- Ask students how a chimpanzee's footprints might be different from the ones their classmates just made. Mention to students that when chimpanzees walk on two legs, their feet are wide apart and they put most of their weight on the outside of their feet. Also, their feet don't have arches like ours do, and their big toes splay out to the side. What footprints would their painted feet leave behind?

Part 2: Laetoli Trackway

E. Introduce the Laetoli trackway:

- Hand out or project one copy of the 10-inch Laetoli trackway illustration to each group of two students. Explain to students that this is a small portion of the overall trackway. The name on the illustration says that it is a "photogrammetric plan," which means it's a map constructed from a photograph. As explained in the student handout, the number of contour lines within the footprint indicates its depth.
- Help students understand that the depth of a particular area of the print indicates how much weight was placed on that area. Refer them back to the inferences they made about the footprints in the classroom trackway—most of the weight was placed where the paint was darkest. Here, most of the weight was placed where there are many lines close together.
- Orient students to the trackway. There are two sets of prints in the trackway, one labeled G.1 and the other G.2/3.

F. Make observations and inferences:

- Ask students to examine the tracks and to discuss with a partner what they see, as outlined in Part 2, questions 8–10 of the student handout. After a few minutes, have the groups share their observations.
- During the discussion, reinforce the difference between observations and inferences by asking students, *Is this an observation or an inference?*
- Students may have difficulty identifying exactly how many individuals made these footprints. Some anthropologists noticed that it looks as though there are two distinct heel prints within each "foot." Ask your students if they can observe the same. The scientists inferred that two individuals made this set of prints, with a smaller individual stepping into the tracks of the larger individual. Ask, *How would we know that the smaller individual stepped into the print of the larger individual and not the other way around?*

If the smaller individual had gone first, its prints would have been obliterated by the larger individual's prints.

- Look at the other set of prints labeled G.1-35, G.1-34, and G.1-33. Ask*, Do these prints line up with the larger set of prints (the ones labeled G2/3)? What can you infer based on this observation?*

Because the two sets of prints are "walking in step," it's likely that the footprints were made at the same time, and that the individual who made the smaller prints was walking very close to one of the two who made the larger ones.

- Consider doing a demonstration: You might want to ask for two volunteers to demonstrate how far apart they would need to stand to produce those footprints.
- Ask your students to speculate: *How might these three individuals have been related?*

They may have been family: a father, mother, and child.

Part 3: Chimpanzee and Human Footprint Comparison

G. Complete the handout:

- Distribute Part 3 of the handout, the summary activity. Have students refer to the footprint characteristics in Table 1 and answer the questions following the table. After time for individual work, ask for volunteers to describe their answers to **Part 3, question 11**, evidence that the Laetoli footprints were made by a bipedal primate (human) and not a quadrupedal one (chimpanzee).
- When you discuss **Part 3, question 12**, remind students that the rock in which the Laetoli footprints were found is 3.6 million years old. This means that our human ancestors were fully bipedal by that time. However, it is not possible to determine when bipedalism first evolved based on the Laetoli footprints alone. By examining other fossil evidence, scientists have looked for evidence of bipedalism before and after the time of the footprints to pinpoint the origin of this anatomical adaptation. Scientists have analyzed a large body of evidence to reconstruct our evolutionary past, including the fossils and DNA of many hominids.

H. Discuss the activity further:

- Ask students to compare the footprints made by the volunteers to those on the Laetoli trackway. What similarities do they notice? What differences?
- Footprints are affected by how hard or soft the ground is. As you discuss the questions about the Laetoli tracks, get your students to think about how extraordinary they are because the ground had to be soft enough to capture the prints, but not so soft that all detail was lost. To help them understand, you may ask them to think about how their own footprints are affected by the softness of the ground. Have them imagine walking across a dry field and through a thick, muddy field. Would either environment leave good footprints? What type of environment would leave good footprints, and what would have to happen for those footprints to be preserved?

RELATED RESOURCES

- References and resources that cover a wide range of topics related to evolution can be found at the UC Berkeley Understanding Evolution website.
- References and resources related to human origins can be found at the Smithsonian Institution's What Does It Mean to Be Human? website.
- A more in-depth activity related to the Laetoli trackway, "Footsteps in Time," is archived on the ENSIWEB website.

REFERENCES

Flammer, Larry, Jean Beard, Craig E. Nelson, and Martin Nickels. ENSIWEB (Evolution/Nature of Science Institutes). 1998. Accessed September 15, 2015, from http://www.indiana.edu/~ensiweb/.

Randak, Steve. "Footsteps in Time: Analysis of the Laetoli Footprints." ENSIWEB. 1998. Archived: https://web.archive.org/web/20180322092010/http://www.indiana.edu/~ensiweb/orig.fs.html.

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