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Evolutionary Changes In Primates

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When paleontologists discover fossils, they determine whether they have discovered fossils of recent or early organisms. They then determine the kinds of organisms the fossils represent. If a skull were discovered and determined to be a primate skull, the next step would be to determine whether it is of an ape or a human. Because evolutionary change has occurred in both groups, the skull could be of early or modern ape or early or modern human. Because humans and apes evolved along separate lines, certain physical characteristics can be used in an attempt to classify the fossil skull as belonging to either ape (early or modern), early human, or modern human. Techniques similar to the ones used in this investigation are used by anthropologists, paleontologists, and archeologists.

In this investigation, you will

(a) examine gorilla, early human, *Australopithecus*, and modern human skull and pelvic diagrams.
(b) measure or observe and record specific skull and pelvic structures and features.
(c) evaluate evolutionary changes that have occurred in these organisms.

Materials

metric ruler
protractor

Procedure

Part A. Skull Characteristics

Brain Area Compared To Face Area

The rectangles over the skulls in Figure 1 represent the area of the brain (upper rectangle) and face (lower rectangle) of each skull.

- Determine the area of each rectangle by measuring the length and width in centimeters and multiplying the two measurements together.

- Record in lines 1 and 2 of Table 1 the brain and face areas for the gorilla, *Australopithecus*, and modern human skulls.

A comparison can be made as to whether the brain area is larger or smaller than the face area.

- Compare the brain and face areas and complete lines 3, 4, and 5 of Table 1.

Cranial Capacity

- Measure the diameter in centimeters of the circle in each skull. The diameter is the distance across the exact center of each circle.

- Multiply the cranial diameters by 200 cm^3. This gives the cranial capacity (brain volume) in cubic centimeters.

- Record the cranial capacity for each skull in line 6 of Table 1.

NOTE: This method of measuring cranial capacity differs from the method used when an intact skull is available.

Jaw Angle (Prognathism)

In front of each skull are two heavy lines, one running parallel to the slope of the upper jaw and one running through the nose. These two lines are to be used for measuring how far the jaw protrudes forward.

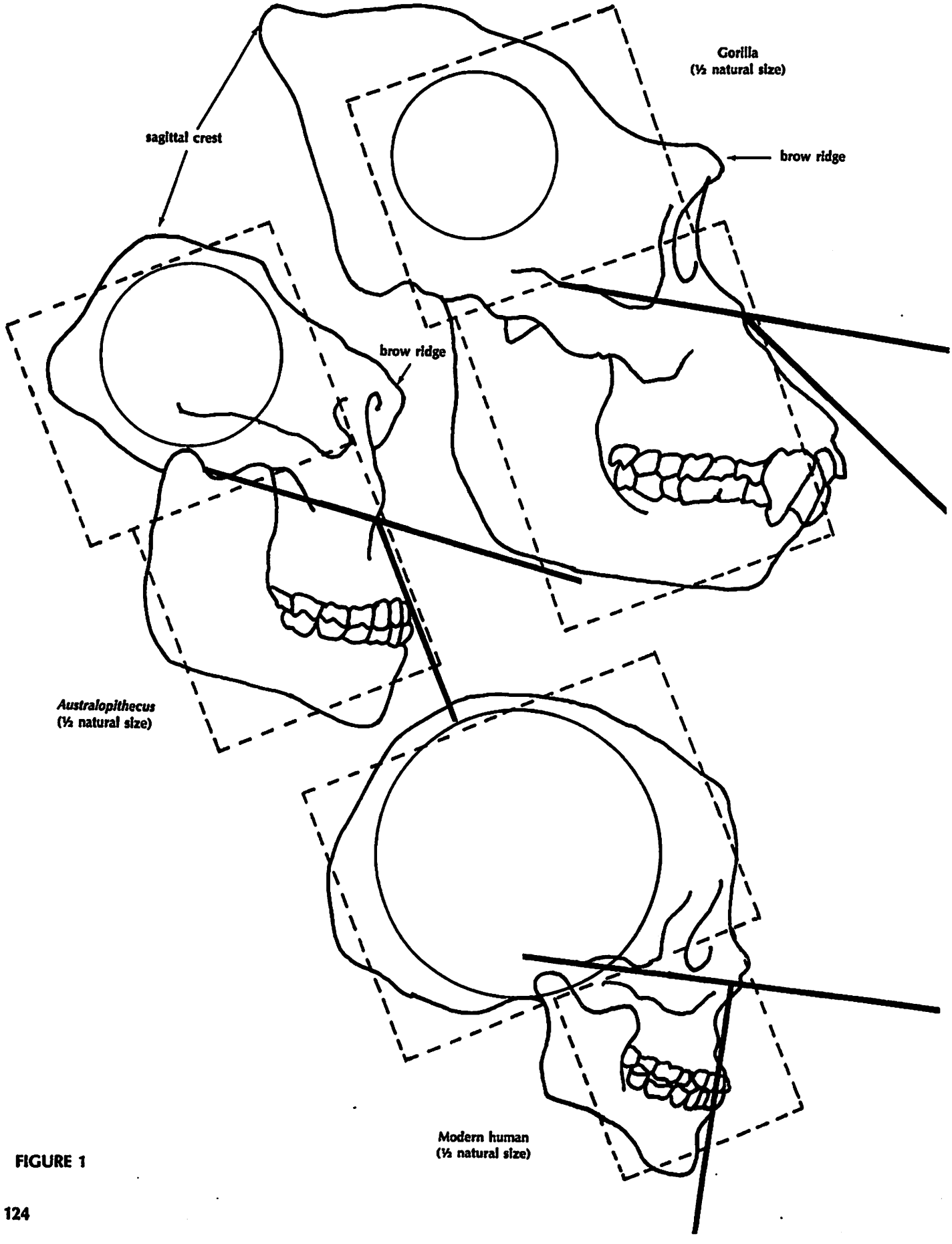
Gorilla
(½ natural size)
sagittal crest
brow ridge
brow ridge
Australopithecus
(½ natural size)
Modern human
(½ natural size)

FIGURE 1

• With a protractor, measure the outside angle formed by the two lines in each skull (the angle toward the right).

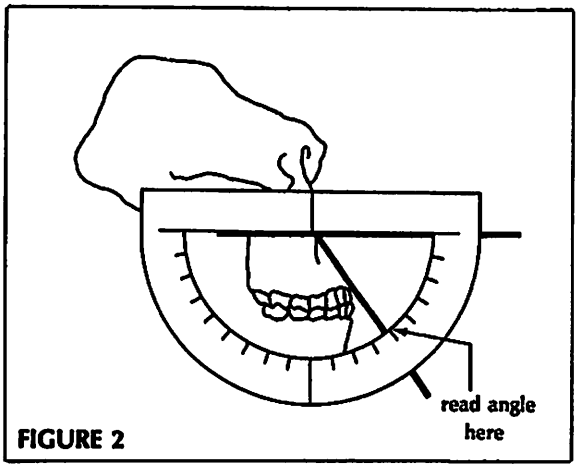

FIGURE 2

• Place the protractor onto each skull as shown in Figure 2. Read the angle by using the outside scale on the protractor. The angle is read where the lower skull line crosses the protractor.

• Record the angles in line 7 of Table 1. An angle of less than 90° means that the lower jaw sticks out in front of the nose. An angle of 90° means that the lower jaw does not stick out in front of the nose. Complete line 8 of Table 1.

Sagittal Crest

A bony ridge running across the top of a skull for muscle attachment is called a sagittal crest. This bony ridge is associated with heavy temporal muscles used to move the lower jaw.

• Indicate in line 9 of Table 1 whether a sagittal crest is absent or present in each skull. Refer to Figure 1.

Brow Ridge (Supraorbital Ridge)

Directly above the eye sockets is a thick bony ridge. This ridge may be absent or present in a skull.

• Indicate in line 10 of Table 1 whether or not a brow ridge is present.

Numbers and Types of Teeth

Use Figure 3 for this part of the investigation.

• Count and record the number of teeth for each lower jaw in line 11 of Table 1.

• Count the number of each tooth type for each lower jaw. "M" on Figure 3 is for molar, "P" is for premolar, "C" is for canine, and "I" is for incisor.

• Record in lines 12 to 15 of Table 1 the tooth type totals.

• Record in line 16 of Table 1 the size of canine teeth in each lower jaw.

• A diastema is a space between teeth. One can see a space in the lower jaw of the gorilla between the incisor and canine teeth. When the jaws were closed, the diastema allowed room for the large incisor teeth of the upper jaw. Record in line 17 of Table 1 if a diastema is or is not present in each lower jaw.

Lower Jaw Shape

The distance across the jaw backs compared to the distance across the jaw fronts can be used to determine jaw shapes of the three organisms in Figure 3 on page 127.

• Measure in centimeters the distance across each jaw from one dot to the other on the back molar teeth.

• Measure the distance across each jaw using the dots on the front pre-molar teeth.

• Record the distances for each jaw in lines 18 and 19 of Table 1. The distance across the back and front of a lower jaw will help to determine if the jaw is U- or V-shaped.

If the distance across the back of the jaw is the same as the distance across the front of the jaw, the jaw has a U shape. If the distance across the back is greater than the distance across the front, the jaw has a V shape. Complete lines 20, 21, and 22 of Table 1.

Pelvis Shape

Examine Figure 4. It shows the pelvises of our three skeletons from a side view. A line has been drawn across each one to indicate top and bottom.

• Record in line 23 of Table 1 if the top half of each pelvis is wide and short or narrow and long.

• Record in line 24 of Table 1 if the bottom half of each pelvis is short or long.

TABLE 1. COMPARISON OF GORILLA, *AUSTRALOPITHECUS*, AND MODERN HUMAN SKULLS			
	GORILLA	*AUSTRALOPITHECUS*	MODERN HUMAN
1. Face area			
2. Brain rea			
3. Is brain area smaller than face area?			
4. Is brain area larger than face area?			
5. Is brain area 3 times larger than face area?			
6. Cranial capacity in cm^3			
7. Jaw angle			
8. Does lower jaw stick out in front of nose?			
9. Sagittal crest present			
10. Brow ridge present			
11. Number of teeth in lower jaw			
12. Number of molars in lower jaw			
13. Number of premolars in lower jaw			
14. Number of canines in lower jaw			
15. Number of incisors in lower jaw			
16. Size of lower jaw canines			
17. Diastema present			
18. Distance across back of jaw			
19. Distance across front of jaw			
20. Is distance across front and back of jaw the same?			
21. Is lower jaw U-shaped?			
22. Is lower jaw V-shaped?			
23. Shape of top half of pelvis			
24. Shape of bottom half of pelvis			

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FIGURE 3

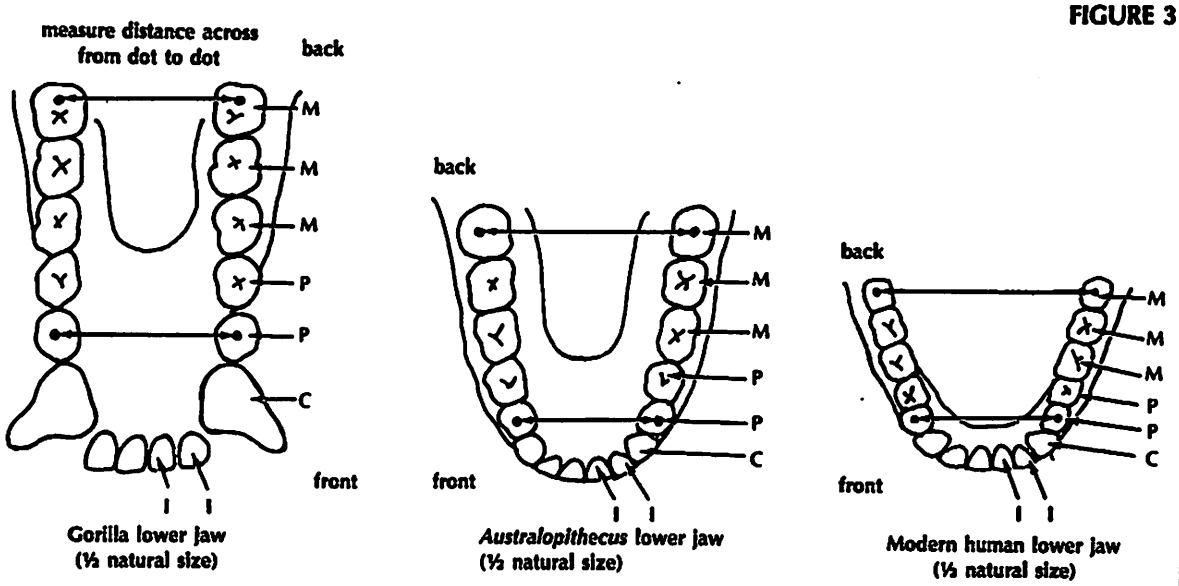
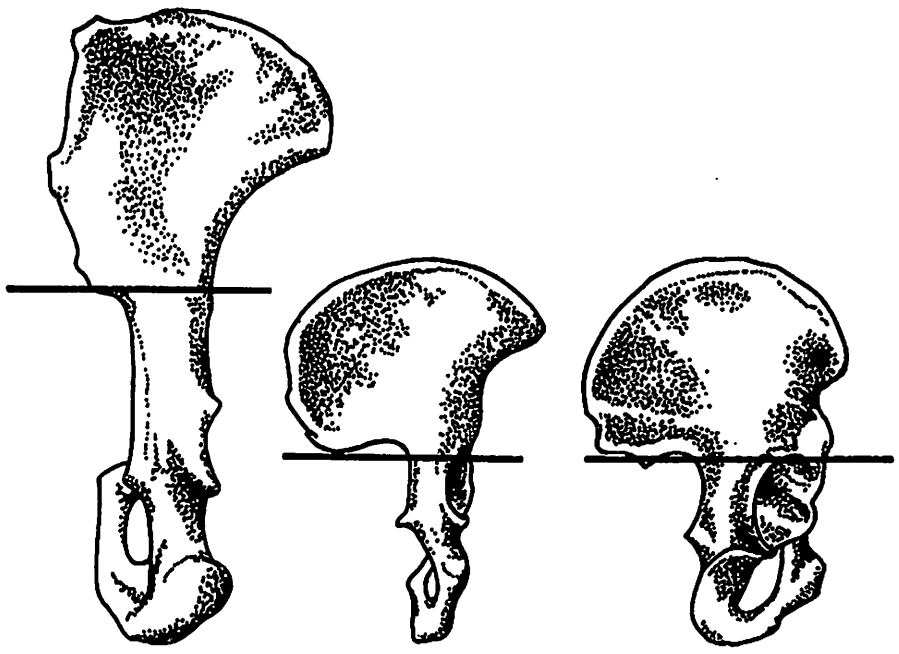


FIGURE 4



Analysis

1. Using items 1–5 of your data in Table 1, describe the general change in face to brain area seen in the three animals studied. _____

_____

_____

2. Using item 6 of your data, describe the general change in cranial capacity seen in the three animals studied. _____

_____

3. Using items 7 and 8 of your data, describe the general change in jaw angle and prognathism (how far the jaw protrudes forward) in the three animals studied. _____

_____

_____

4. Using items 9 and 10 of your data, describe the general change in brow ridge and sagittal crest in the three animals studied. _____

_____

5. Using items 11–17 of your data, describe the general change in teeth number, size, and diastema in the three animals studied. _____

_____

6. Using items 18–22 of your data, describe the general change in lower jaw shape in the three animals studied. _____

_____

7. Using items 23 and 24 of your data, decide if *Australopithecus* was quadrupedal or bipedal. (The gorilla pelvis shape aids in its "walking on all fours," which is quadrupedal. The human pelvis shape aids in its walking on two legs, which is bipedal.) _____

8. How many traits are similar when comparing

   (a) gorilla to *Australopithecus*? _____

   (b) *Australopithecus* to modern human? _____

   (c) gorilla to modern human? _____

9. Based on your answer to question 8, does a modern human seem to be closer in evolutionary development to gorilla or *Australopithecus*? _____