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Asymmetry in Gorilla Skulls: Evidence of Lateralized Brain Function?

ASYMMETRY in mammalian skulls is a rare phenomenon. Differential tusk usage in elephants may result in slight skull asymmetry[1], and the Odontoceti (toothed whales) invariably show marked skull asymmetry caused by suppression of the nasal passage on one side. This is carried to an extreme in the Narwhal, in which a long tusk is almost always developed on the left side only.

Human skulls usually show a weak asymmetry, especially of the brain case. Hoadley and Pearson[2] measured the right and left internal lengths of the skull in 729 male Egyptian skulls belonging to the twenty-sixth to thirtieth Dynasty and found the mean length to be slightly greater on the right side than on the left (*R*: 171.0 mm, *L*: 170.1 mm). No other primate shows marked asymmetry except the gorilla. Coolidge[3] noted and commented on this circumstance, observing that in "Coast gorillas" (*G. g. gorilla*) the right side of the skull was usually longer, while in "Mountain gorillas" (subspecies *beringei*, to which is now added subspecies *graueri*) the left side was usually longer.

We were struck by the asymmetry in Mountain gorillas (*G. g. beringei, sensu stricto*) while examining a collection of skulls at the camp of Miss Dian Fossey in the Virunga Volcanoes, Rwanda. Of eleven juvenile and adult skulls, four showed very marked asymmetry such that the left side was longer than the right. Only one of the four showed any sign of injury to the masticatory apparatus which might have caused such a condition. (A further skull, presented by Miss Fossey to the Duckworth Laboratory, showed the opposite type of asymmetry, but in this case it was quite clearly the result of extensive pathology of the masticatory musculature.)

We have looked again at Coolidge's data, supplementing them with our own observations on the skulls in the British Museum collection and the Fossey collection. Figure 1 shows the relative frequencies of differences between the length of the two sides of skulls (skull length measured from

the anteriormost point of the temporal fossa to the gnathion). For the Coast gorilla the mean difference, based on a sample of 138 skulls, is 0.1 mm to the right and is not significantly different from zero. For the other two subspecies taken together the mean difference, based on a sample of fifty-five skulls, is 2.5 mm to the left and is highly significant ($P<0.001$ on a t test). Within the second group the bias to the left is greater in subspecies *beringei* than in subspecies *graueri* (mean differences of 2.7 mm and 1.8 mm, respectively), though in both subspecies the difference is significant ($P<0.001$ and $P<0.01$).

Besides looking at the general distribution of skull lengths we have found it useful to examine the incidence of gross skewing of the skull. Such "gross asymmetry" shows up unmistakably when there is a difference of 4 mm or more (roughly 2%) between the skull lengths of the two sides, and

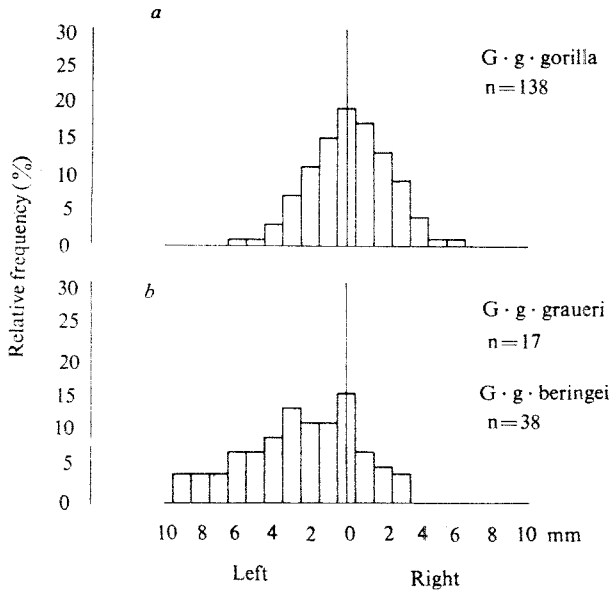

Fig. 1 Relative frequencies of differences between the lengths of the two sides of skulls of *G. g. gorilla*, *G. g. beringei* and *G. g. graueri*. Lengths were measured from the anteriormost point of the temporal fossa to the gnathion. *a*, *G. g. gorilla*, $n=138$; *b*, *G. g. graueri* ($n=17$) and *G. g. beringei* ($n=38$).

is accompanied by proportionate differences in other dimensions of the skull, an obvious lopsidedness of the sagittal crest, heavier toothwear on one side than the other, etc. Gross asymmetry is almost entirely restricted to true Mountain gorillas (*beringei*) (Table 1).

Table 1 Gross Asymmetry in *G. g. gorilla*, *G. g. graueri* and *G. g. beringei*

	Right side longer	Left side longer	No difference
G. g. gorilla	8	8	122
G. g. graueri	—	2	15
G. g. beringei	—	17	21

Gross asymmetry is seen to characterize the true Mountain gorilla to such a degree that almost as many specimens are affected as are not. Moreover, of the unaffected *graueri* sample, thirteen were "true" *graueri* from the Itombwe Mountains and the Utu lowlands, and two were from the equivocal Kayonza Forest population. Of the two affected skulls, one was from Kayonza and the other from the other equivocal population, from Mt. Tshiaberimu.

Cerebral form has little direct effect on the shape of the skull, and we cannot argue with any confidence that these data on the Mountain gorilla reflect an asymmetry in the volume of the cerebral hemispheres. A plausible alternative would be that the skull asymmetry is a secondary consequence of an asymmetry in the use of the masticatory apparatus; for example, a tendency to chew more on the left side than on the right. Consistently one-sided behaviour, though almost unknown for other non-human primates, has been reported for the Mountain gorilla in another context by Schaller[4]. Schaller looked at "handedness" in the chest-beating display of eight Mountain gorillas in the field and found that the right hand was used first in fifty-nine out of seventy-two displays, all eight gorillas showing a right-hand preference. If left-sided chewing is the cause of skull asymmetry in Mountain gorillas, it might explain the absence of such asymmetry in Coast gorillas which have less strongly developed masticatory musculature. The existence of strong jaw muscles, *per se*, cannot be the explanation because orang-utans, which have equally well developed musculature to the Mountain gorilla, do not show comparable skull asymmetry.

Whether the asymmetry in the skull is directly related to anatomical asymmetry of the cerebral hemispheres, or whether it is merely a consequence of asymmetrical behaviour, it may be taken as suggestive evidence that there is asymmetry of function in the Mountain gorilla's brain. Among mammals, lateralization of brain function has so far been demonstrated only in man and is commonly assumed to be associated with the capacity for language.

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C. P. GROVES

Duckworth Laboratory of Physical Anthropology,
Faculty of Archaeology and Anthropology,
University of Cambridge,
Cambridge CB2 3DZ

N. K. HUMPHREY

Sub-department of Animal Behaviour,
University of Cambridge,
Madingley,
Cambridge CB3 8AA

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[1] Sikes, S. K., *The African Elephant* (Weidenfeld and Nicolson, London, 1971).
[2] Hoadley, M. D., and Pearson, K., *Biometrika*, **21**, 94 (1929).
[3] Coolidge, H. J., *Revision of the Genus* Gorilla (Mem. Mus. Comp. Zool. Harvard, **50**, No. 4, Cambridge, Mass., 1929).
[4] Schaller, G. B., *The Mountain Gorilla* (Chicago University Press, 1963).

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