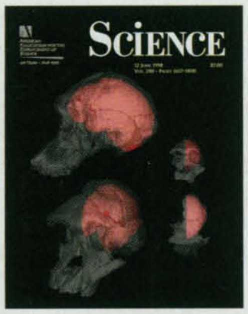
A letter contests the view that a CT scan of *Australopithicus africanus* "is about to wreak havoc on our view of hominid evolution." Other letter writers discuss theropod dinosaur and ancient bird "breathing mechanisms," looking at how "lung ventilation and gas exchange" relate to the dinosaur-origin-of-birds hypothesis.

No Surprises? Dean Falk's Research commentary "Hominid brain evolution: Looks can be deceiving" (*Science*'s Compass, 12 June, p. 1714) contends that "another new speciman...is about to wreak havoc on our view of hominid evolution" and that it changes the big picture. A cranium (Stw 505) found at Sterkfontein, South Africa, in 1989 was no surprise—the site has been producing specimens for more than 50 years. A coffee-table book (*1*) and "the grapevine" speculated that it had a 600+ cubic-centimeter (cm^3) brain. To test this, brain volume was estimated by using a computed tomography (CT) scanner. The digital measure matched the volume obtained by traditional water displacement, but not the coffee-table book or the grapevine. Conclusion: CT scanners are more accurate than rumors. To have these sources match, or to have found a brain, *would* have been surprising. A mere volume of 515 cm^3 for *Australopithicus africanus* is not. Readers still searching for the surprise, anticipating havoc in the field and changes in their "big picture," may be disappointed by these facts, but not all summer "blockbusters" live up to reviews by friendly critics.



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References

1. D. Johanson and B. Edgar, *From Lucy to Language* (Simon & Schuster, New York, 1996).

Response:
Stw 505 is important because of its unexpected cranial capacity of 515 cm^3, which suggests that the cranial capacities of other hominid fossil specimens may have been incorrectly estimated. Since writing my commentary, my colleagues and I have extensively researched the endocasts in our collection and have begun to compare them with 3D-CT reconstructions from the actual specimens from which they were taken. We are mighty surprised, and intend to publish our results as quickly as you can say "*Ardipithecus*." When reading a film review, I always hope that the critic (friendly or otherwise) has actually seen the picture. Worthwhile science, like a credible film review, depends on knowledge of the subject matter. In other words, the proof, as it relates to the significance of Stw 505, is in the pudding. I believe that White and I are both attending a small workshop in August. I'm bringing the pudding. White should bring a spoon.

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Lung Ventilation and Gas Exchange in Theropod Dinosaurs John A. Ruben and his colleagues suggest (Reports, 14 Nov. 1997, p. 1267) that the lung of theropod dinosaurs was most likely similar in form to that of several extant reptiles and was therefore incapable of sustaining high oxygen (O_2) exchange rates characteristic of endothermy. We disagree for two reasons. First, we examined the comparative physiology literature and determined that maximum oxygen exchange rates (VO_2max) of some extant reptiles overlap the oxygen consumption rates measured in some mammals during activity. Specifically, exceptionally active reptiles with multicameral lungs (*1*) (for example, monitor lizards and sea turtles) have values of VO_2max that overlap or approach the oxygen exchange rates measured in similar size mammals during activity (*2*). Therefore, the septate lung in those reptiles must be capable of sustaining rates of gas flux characteristic of endotherms. However, mammals and birds "typically" have a greater VO_2max. Therefore, we addressed the question of what modifications in the oxygen transport system of an extant reptile would be necessary to support higher rates of oxygen consumption.

We used morphological and physiological measurements of extant reptiles and well-established respiratory equations to model the gas exchange potential of the reptilian oxygen delivery system and to examine the role of lung structure in constraining gas exchange. Each step in the oxygen cascade is described by a set of respiratory equations and, consequently, it is possible to describe mathematically the flux of oxygen through the entire cascade and to evaluate the impact of modifications in any of its components (*3*). We used this approach to predict the effects of modifying several parameters in the oxygen cascade on VO_2max in a 1-kilogram lizard, *Varanus exanthematicus* (*4*). Our analysis included four modifications: (i) a small increase in the maximum cardiac output; (ii) an increased oxygen carrying capacity of the blood from reptilian to mammalian values; (iii) an increase in maximum cardiac output combined with the changes in blood oxygen–carrying capacity; and (iv) an increased respiratory gas exchange area in the dorsal region of the lung through elaboration of the intercameral septa with a membranous region in the ventral portion of the lung. Without modification of the lung structure, our analysis predicts that changes in blood oxygen capacity and cardiac output support a VO_2max that is 50% of the value for a "typical" 1-kilogram (kg) mammal (*5*). However, if we combine these changes with conservative modifications in lung morphology, we predict a VO_2max that is nearly 70% of the typical mammalian value. Our analysis indicates that modifications in several of the steps of the oxygen cascade have a cumulative effect on VO_2max (*6*). The resulting high oxygen flux rate mandates an increase in lung ventilation that is 233% above the maximum level measured in extant lizards.

Lizards have a mechanical constraint on simultaneous vigorous locomotion and costal ventilation that arises from the design of the axial musculoskeletal system, and this mechanical constraint was probably the primitive condition for all tetrapods (*7*). Consequently, the fundamental change required to support sustainable high oxygen exchange rates was the development of new mechanisms to increase ventilation (*7*). This constraint has been circumvented to varying degrees in some extant lizards, for example, the use of the gular pump to assist costal ventilation during activity (*8*) and in the lineages that gave rise to endotherms by the evolution of ventilatory mechanics that are not limited by locomotor requirements (*7*).

Inadequate preservation of the soft-tissue components of the oxygen transport