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ANATOMY OF THE BRAIN AND VESTIBULAR APPARATUS IN TWO PTEROSAURS: IMPLICATIONS FOR FLIGHT, HEAD POSTURE, AND BEHAVIOR

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Comparison of birds and pterosaurs, the two archosaurian flyers, sheds light on adaptation to an aerial lifestyle. The neurological basis of control holds particular interest in that flight demands on sensory integration, equilibrium, and muscular coordination are acute. We compared the brain and vestibular apparatus in two pterosaurs: a more basal form (*Rhamphorhynchus*, Jurassic, Solnhofen, Germany) and a derived pterodactyloid (*Anhanguera*, Cretaceous, Santana, Brazil). One skull of each was acid-prepared and then CT scanned to construct digital endocasts. We can confirm some previous findings: e.g., in both

taxa the cerebrum and cerebellum are expanded, displacing the optic lobes ventrolaterally, and olfactory areas are small. Although the general organization resembles birds, our findings corroborate the notion that pterosaurs had relatively smaller brains relative to body mass than do birds. This disparity probably has more to do with phylogeny than flight in that birds evolved from nonavian coelurosaurian theropods that already had established trends for greater encephalization. The enormous size of the cerebellar auricle (flocculus) was unexpected in the pterosaur endocasts, in both cases reaching or exceeding the volume of the optic lobes. Likewise, the semicircular canals are relatively very large. These findings are related in that the cerebellar auricle's role in extant taxa is largely to receive inputs from the vestibular system (semicircular canals, etc.). Thus, these pterosaurs clearly had a highly refined organ of equilibrium. Perhaps most exciting, orientation of the vestibular apparatus relative to the long axis of the skull was very different in these two species, suggesting dramatically different head postures. In *Rhamphorhynchus*, the long axis was more or less horizontal, whereas in *Anhanguera* it strongly angled down. These different head postures probably reflect differing behaviors, perhaps in regard to feeding, but also, given aerodynamic effects, in regard to flight.