“THE CEREBELLUM AND COGNITIVE EVOLUTION IN PLIOCENE AND PLEISTOCENE HOMINIDS”

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ABSTRACT

In the course of hominid evolution, the both the cerebellum and the neocortex have expanded, but they have done so at different rates. Differences in relative cerebellar volume with respect to overall brain and body size among Pliocene and Pleistocene hominids correlate with archeological and skeletal indicators of cognitive evolution.

The cerebellum and the neocortex process information in different but complementary ways. The neocortex manipulates mental representations of objects, concepts, and events using data-rich “declarative” learning and memory processes. The cerebellum, on the other hand, uses “procedural,” rule-based and hierarchically organized functions to coordinate a continuum of sensory-motor and cognitive neural representations (Parkins 1997; Ullman in press).

The present study used integrated data from Magnetic Resonance Images of living human and non-human primate endocrania and three-dimensional virtual models of hominid endocasts. Reduced major axis and least squares regression were used to calculate actual/predicted cerebellar volume with respect to brain volume (“cerebellar quotient” = “CQ”) for a sample of living primates, including recent humans, and fossil hominids.

The evidence supports a three-stage model of hominid cerebellar evolution. In the first stage, brain mass expanded non-allometrically with respect to body mass (encephalization). CQ increased in parallel with encephalization, as *H.* habilis and *H. erectus* gradually developed a high level of technological competence, reflecting well-developed procedural cognitive processes and cultural mechanisms for disseminating technological information. In the second stage, represented by Middle Pleistocene, Late Archaic, and Early Modern *Homo sapiens*, absolute cerebellar volume increased only slightly, accompanied by a dramatic expansion of the neocortex, resulting in a marked decline in CQ. Neocortical expansion supported declarative knowledge with respect to the rich repertory of objects and activities and their mental representations. In the third stage, *after* the emergence of early anatomically modern humans, both brain and body mass were reduced, but absolute and relative cerebellar volume increased. Cerebellar algorithms for manipulating sensory-motor representations were extended to manipulation of conceptual representations as well. Computational efficiency was increased without an increase in overall brain mass.