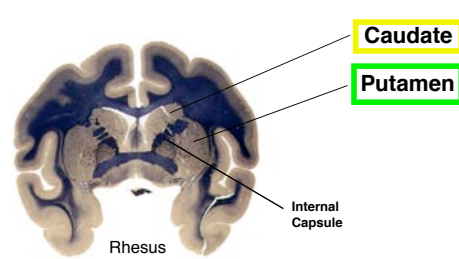


Phylogenetic Comparison of Volume Ratios of Caudate and Putamen

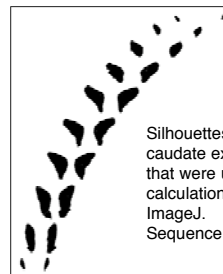
M. L. Whitson, J. A. Baun, *R. C. Switzer III; NeuroScience Associates, Knoxville, TN 37934



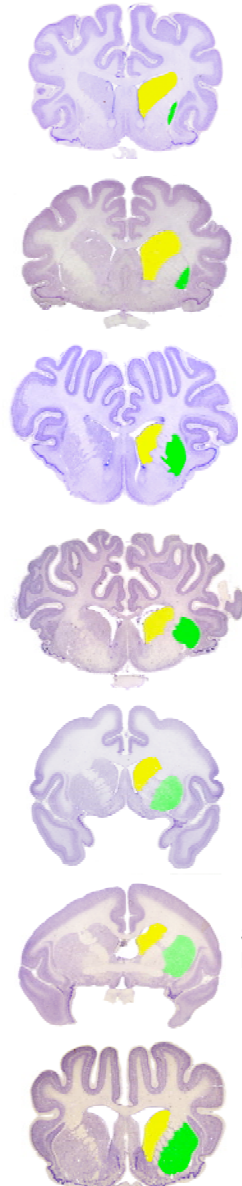
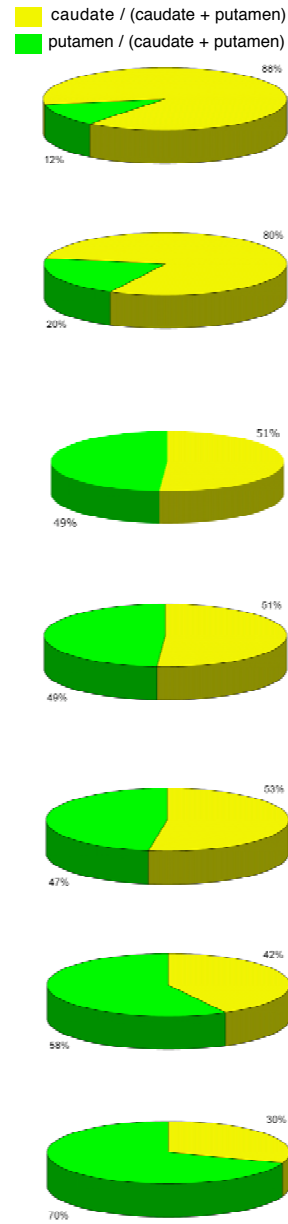
Coronal sections through the forebrain of primate brain display a familiar view of the internal capsule separating the caudate and putamen. A cursory review of images from diverse species found in the website <http://brainmuseum.org/sections/index.html>, indicates that most mammals have this characteristic feature with the exception of animals such as rats and mice. The presence of a caudate separated by the internal capsule from the putamen does not appear to be a function of gyrencephaly or lissencephaly nor of mere size.

A further comparison of the different species leaves the impression that in some animals, such as dog, the caudate is much larger than the putamen, whereas in primate the two are more equitable. To determine if this difference was illusory or real, the ratio of the volumes of putamen and caudate were determined from sections from the brains of dog (beagle; *Canis familiaris*) and of a primate (African Green monkey; *Chlorocebus sabaceus*). The impression was confirmed and the study was extended to include other species for a better phylogenetic representation. Images of brain section images from the brainmuseum.org website for goat, cat, hyrax and squirrel monkey were used for volume calculations. Images of the pig brain were derived from NSA's slides.

Sections stained for nissl substance and myelin were used to delineate and measure the areas (Image J) of putamen and caudate in a series of uniformly spaced slides from the rostral to caudal limits of both structures. Using Simpson's approximation formulae the volumes for each structure were determined and ratios calculated.

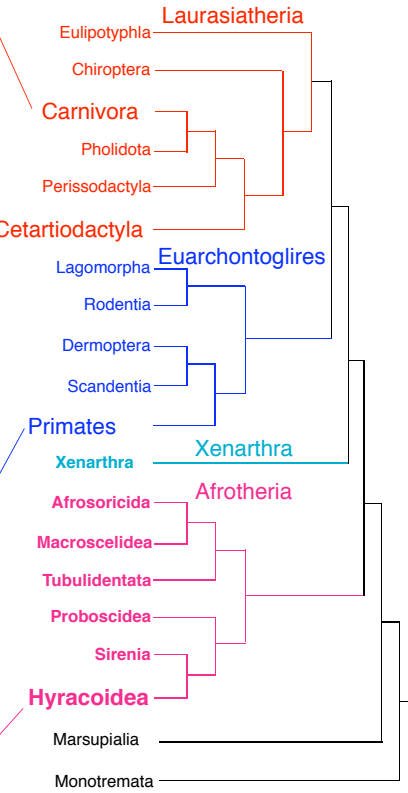


Silhouettes rostral to caudal of blackened caudate extracted from captured images that were used for area and volume calculation using thresholding methods in ImageJ. Sequence from Dog brain.



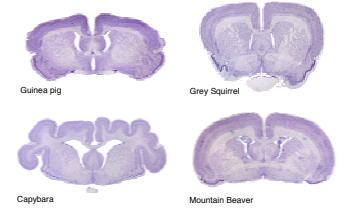
Dog
Cat
Pig
Goat
African Green Monkey
Squirrel Monkey
Hyrax

The molecular based tree of the 4 clades of placental mammals is shown in different colors. The animals examined are representative of 3 of the 4 clades.
Diminutive proportional size of the putamen to the caudate in cat and dog seems unique within this sampling even within the same clade, Laurasiatheria. Examination of other carnivores as well as other species across all clades should reveal the extent of this uniqueness.
The opposite proportion of putamen greater than caudate occurs in hyrax and warrants further examination of other members of clade Afrotheria.



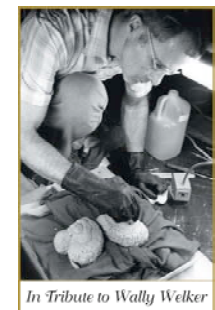
Phylogenetic tree redrawn from Figure 1 Springer et.al. Trends in Ecology and Evolution, vol.19 August 2004, 430-437.

Rodents' internal capsule: to coalesce or not to coalesce to create a Caudate and Putamen



Caudate and putamen are collectively known as striatum and receive input from most of cortex, but with regional differences. It is perhaps such differences that govern the dynamics of brain development and determine just where the components of the internal capsule will coalesce and divide caudate from putamen as occurs in most species or does not as in rats and mice. Similar 'forces' may be at play in deciding how cortex is folded and have been discussed by Welker et. al. (Welker W. Why does cerebral cortex fissure and fold? A review of determinants of gyri and sulci. Jones EG, Peters A, eds. (1990) Vol. 8b. New York: Plenum Press. 3-136. Cerebral cortex). Other instances of fiber pathway variations have been observed that follow phylogenetic groupings. (Switzer, R.C., Johnson, J.I. and Kirsch, J.A.W.: Phylogeny through brain traits: The relation of the lateral olfactory tract fibers to the accessory olfactory formation as a palimpsest of mammalian descent. Brain, Behavior and Evolution 17: 339-363, 1980).

We would like to dedicate this study to Wally Welker, University of Wisconsin, whose devotion and work has been a cornerstone for comparative neuroanatomy. Without the fruits of his work, studies such as this would not be possible.
W.I. Welker 1926-2007



In Tribute to Wally Welker