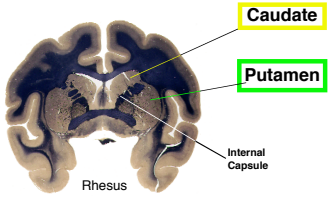
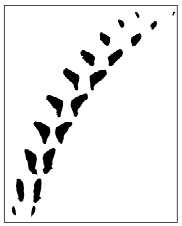
Phylogenetic comparison of volume ratios of caudate and putamen in mammals

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

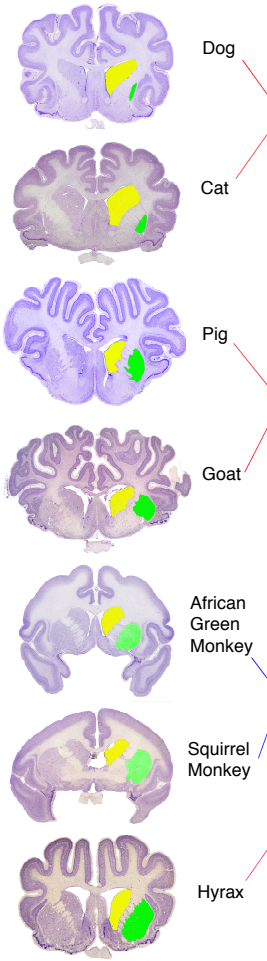


Introduction:
Previously, we have shown differences in the familiar view of the internal capsule separating the caudate and putamen in coronal sections through the forebrain. A cursory review of images from diverse species in the website, *http://brainmuseum.org/sections/index.html*, indicated most mammals have this characteristic feature with the exception of some 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 brain size. A comparison of the different species showed that in some animals, such as dog, the caudate is much larger than the putamen, whereas in primates the two are more equitable. We have extended this study from 7 animals across the mammalian phylogenetic taxa, to 32, including some marsupials.

Methods:
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 tracings of caudate and putamen from multiple coronal levels, the volumes of each structure were computed using Simpson's approximation formula, and ratios of one to the other caclulated.



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



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

Results: The proportion of caudate to putamen is consistently large in the Carnivora, while the putamen is largest in primates and other species such at hyrax and porcupine. Within a given clade there is no consistency in the ratio of caudate to putamen but there are trends.

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.
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).

Results (continued)
In seeking factors that might explain the diverse ratios, we found that grouping animals rather simplistically by diet correlated with the low and high ratios.
Average proportions for 'diet' groups:

This study is dedicated 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