Developmental Bases of Species Differences in Brain Region Size

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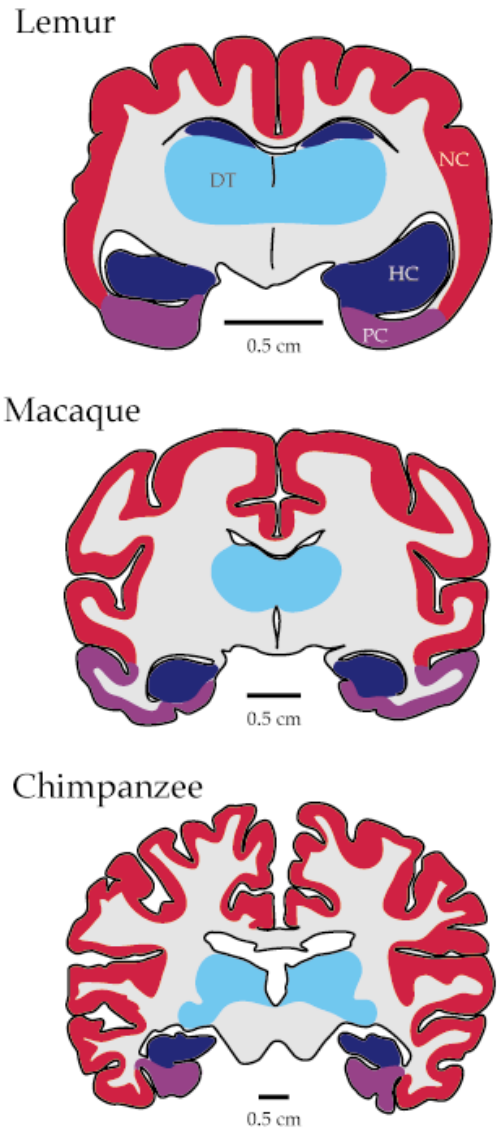
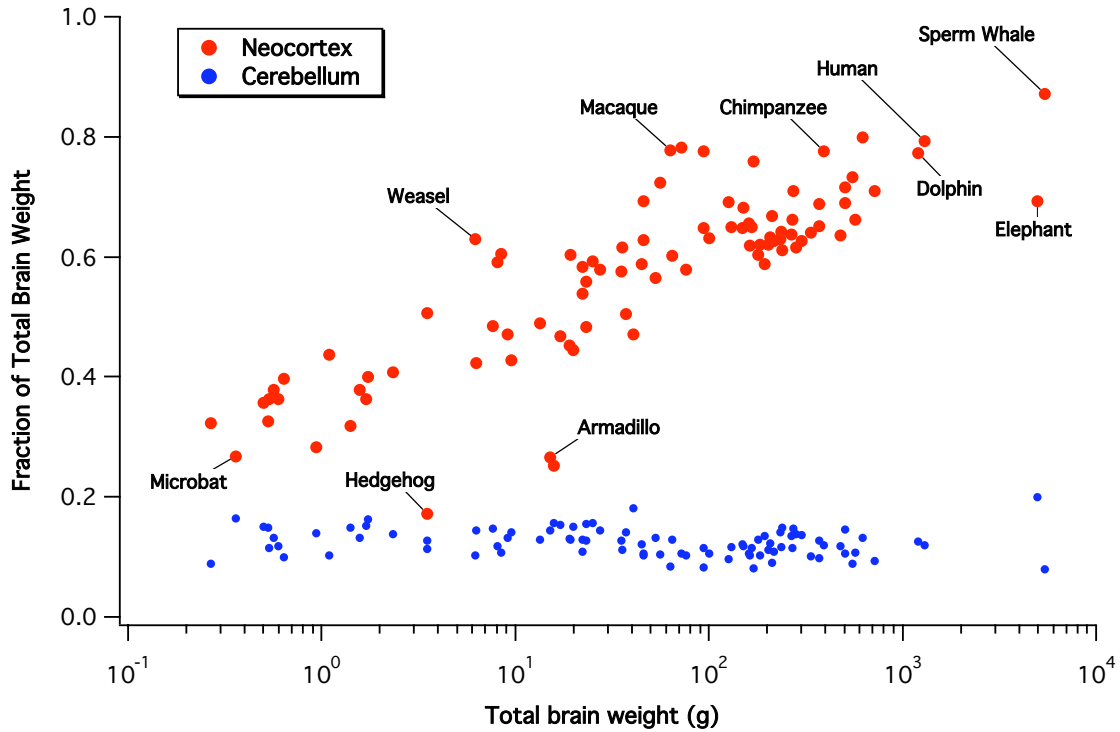
some of this is published:

Journal Comparative Neurology, 2008

with Christine Charvet

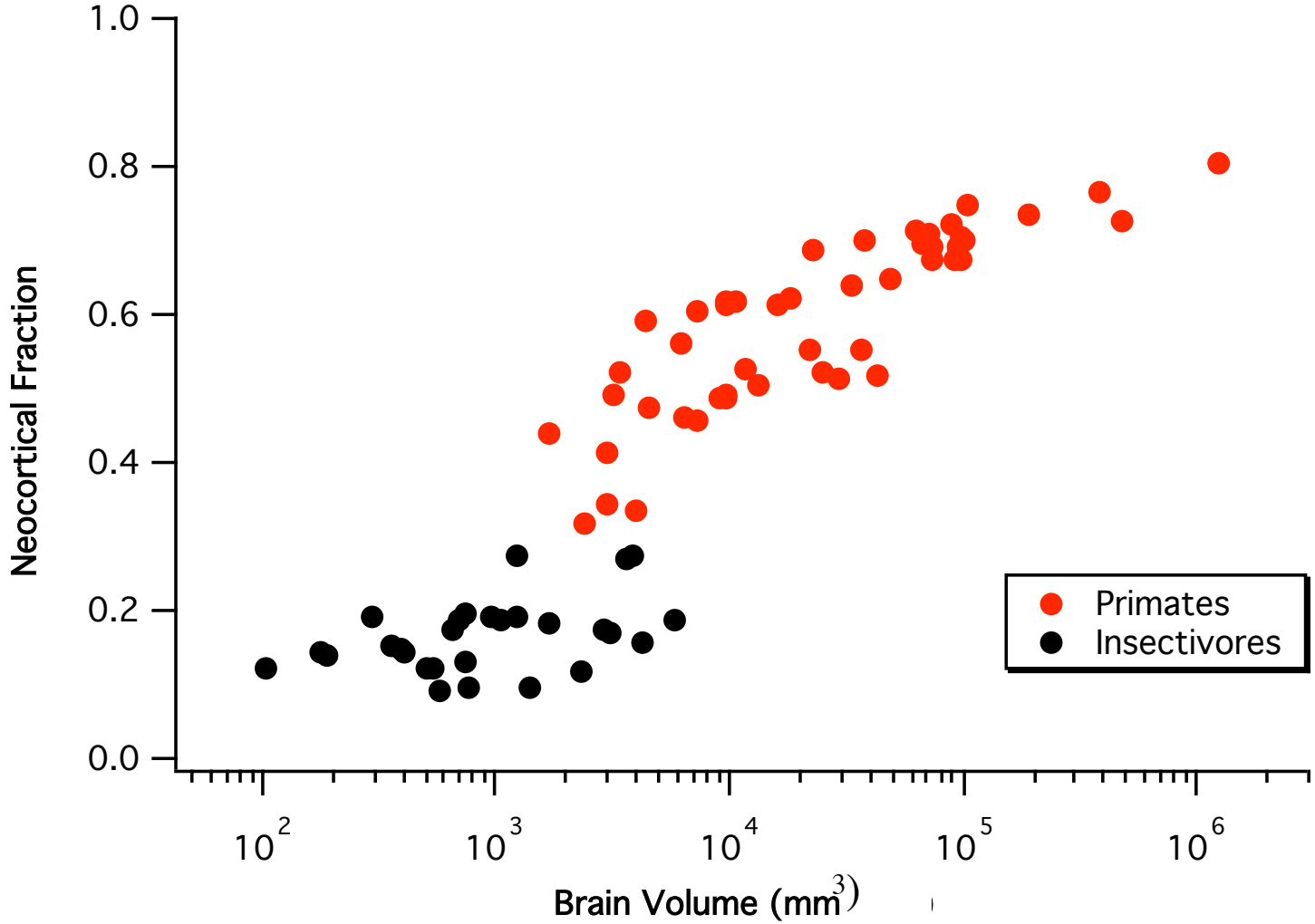
Brain Proportions Vary Across Species





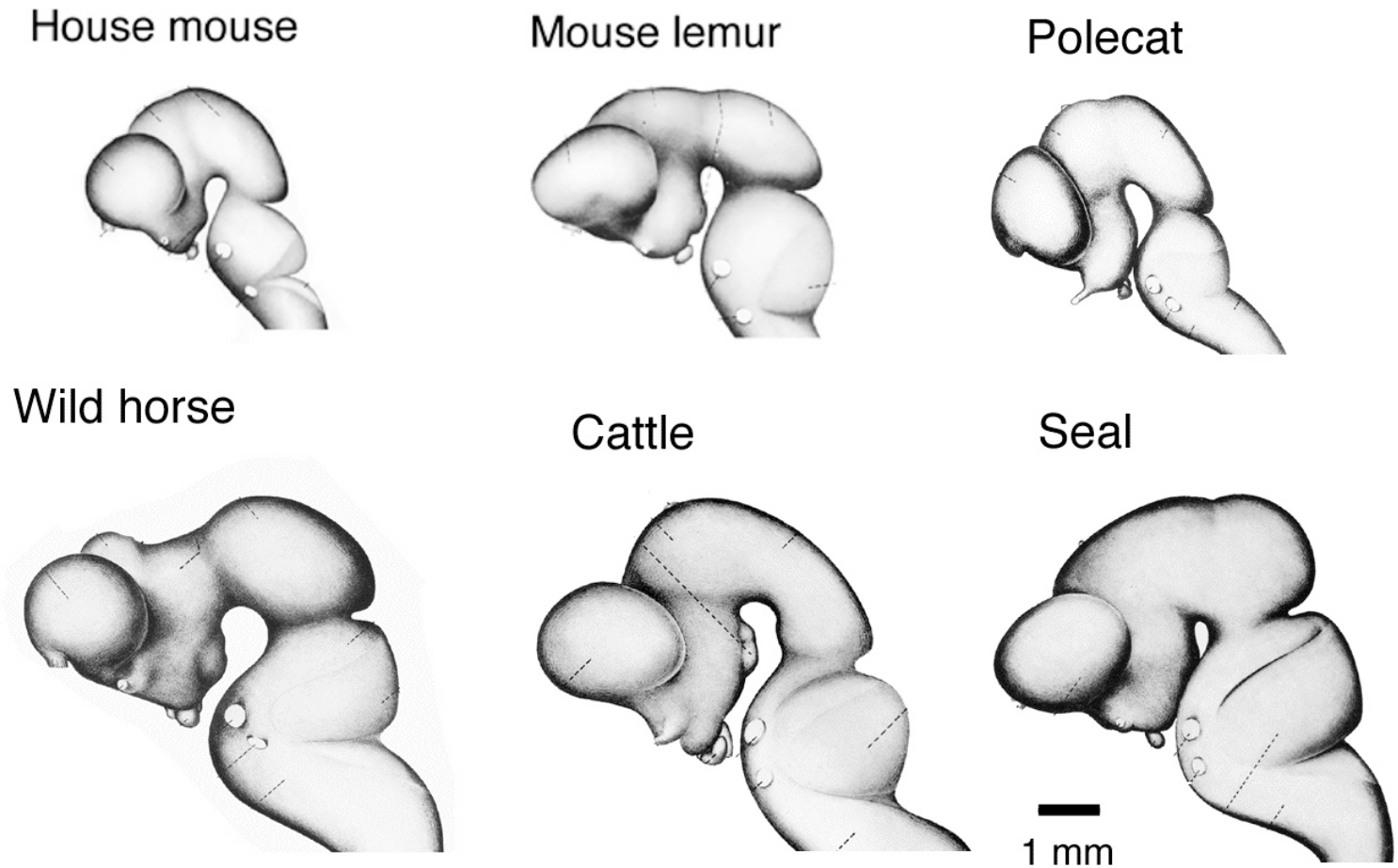
Data from Mangold-Wirz (1966)

Even same-sized brains can vary in their proportions



Data from Stephan et al., 1981

Conservation of Early Embryonic Brains



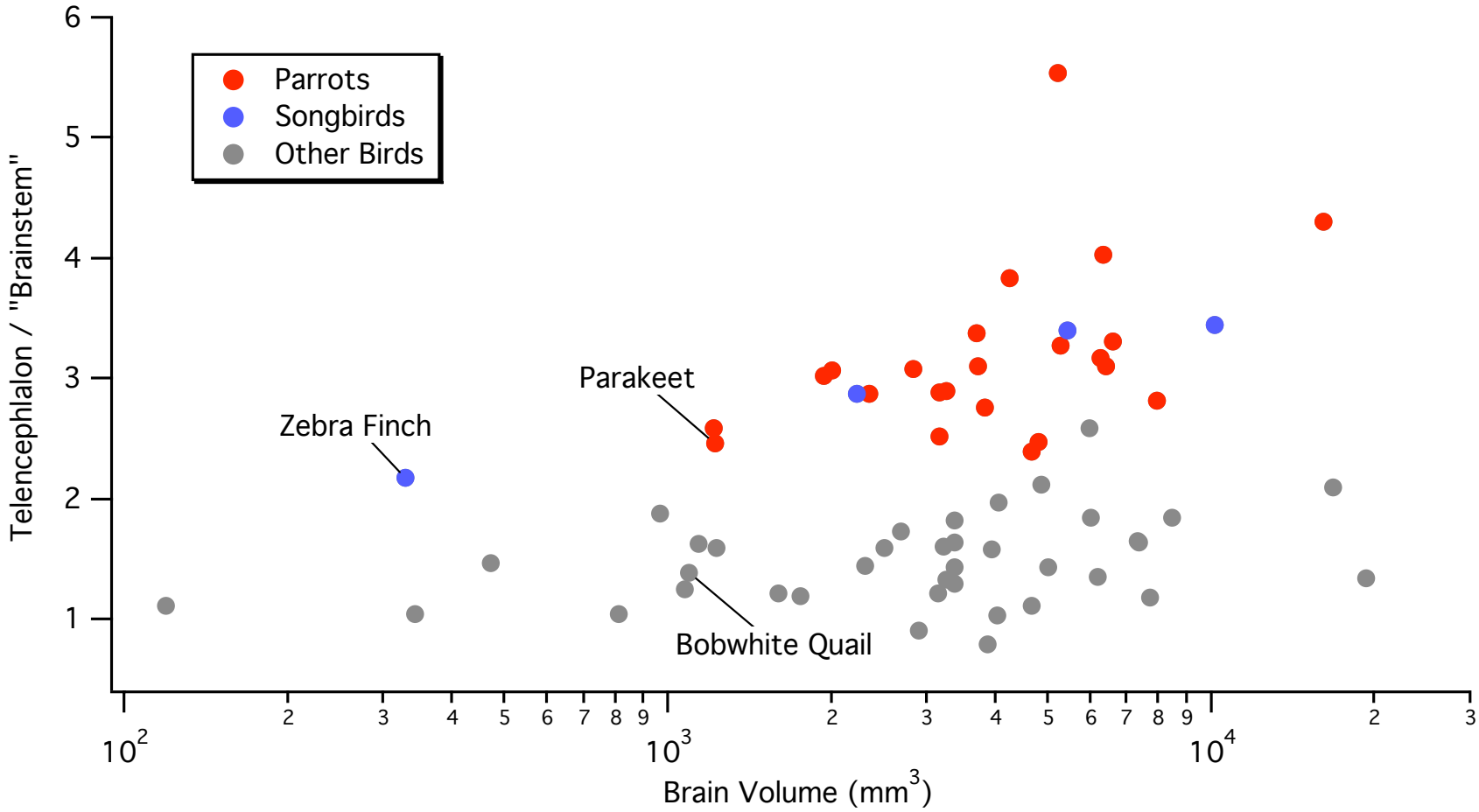
Knud H. Krabbe (1939-1962)

Birds are ideal for comparative neuroembryological studies

Parakeet
(Budgerigar)

Northern
Bobwhite
Quail

Parrots have a proportionately large telencephalon

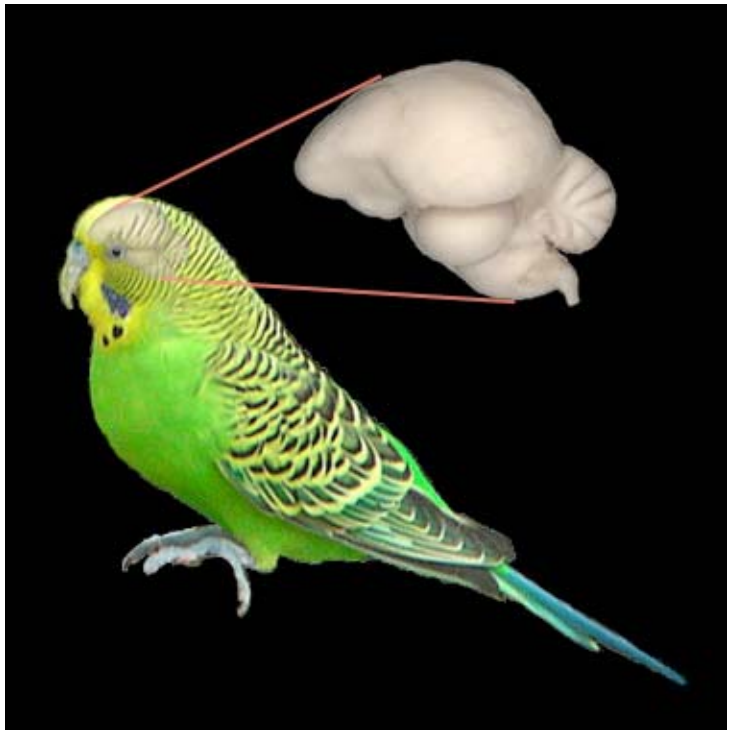


Data mostly from Boire & Baron, 1994

Budgerigars

hatch at 18 days

25 days

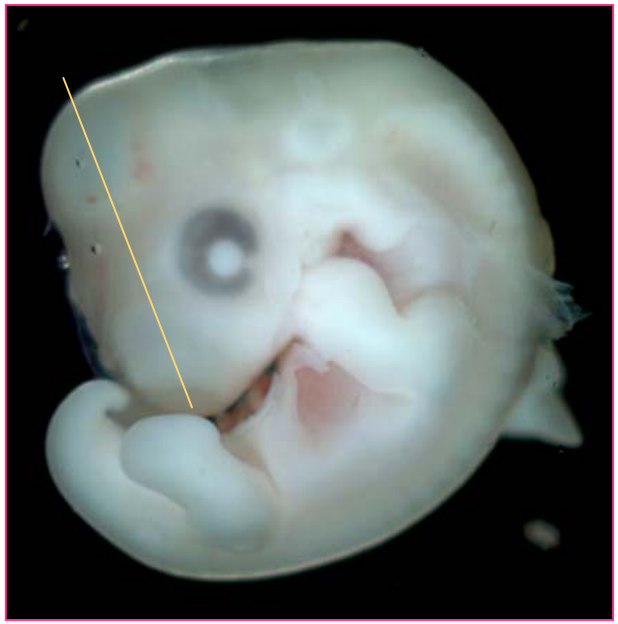


adult

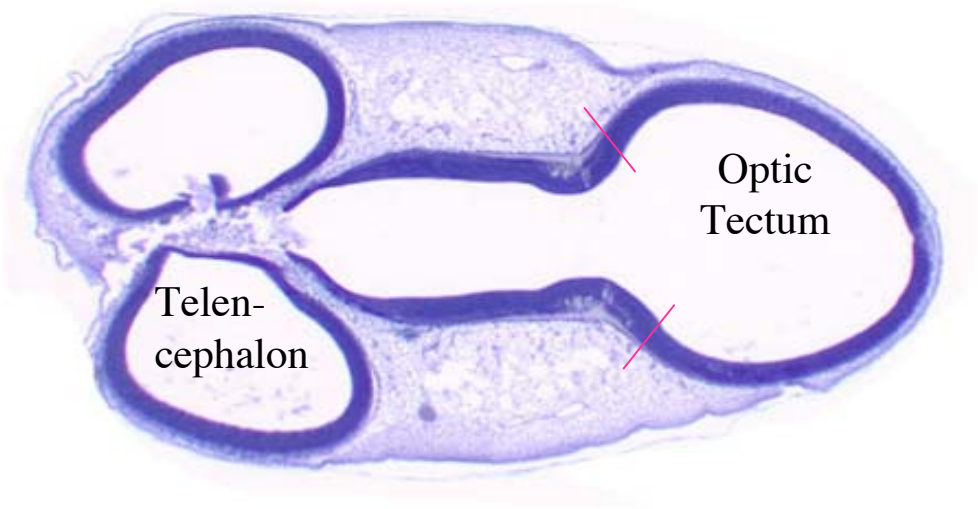
Bobwhite Quail

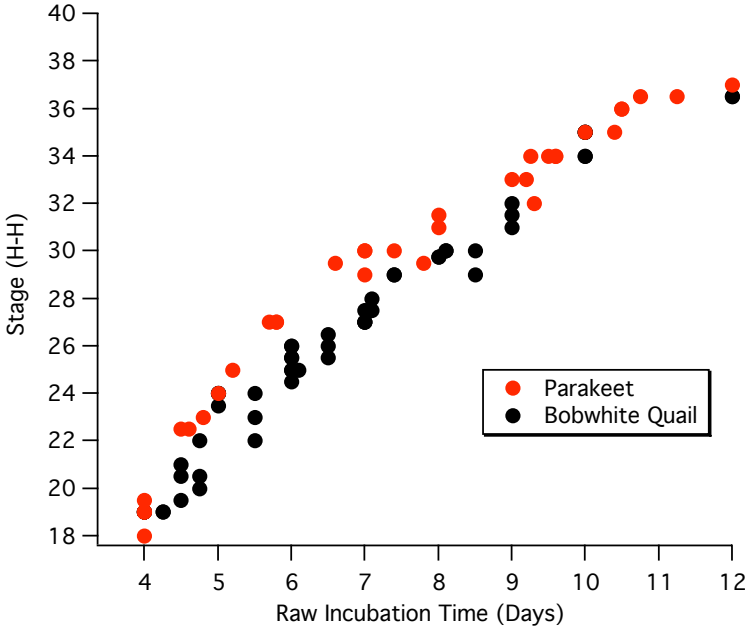
hatch at 23 days

Methods



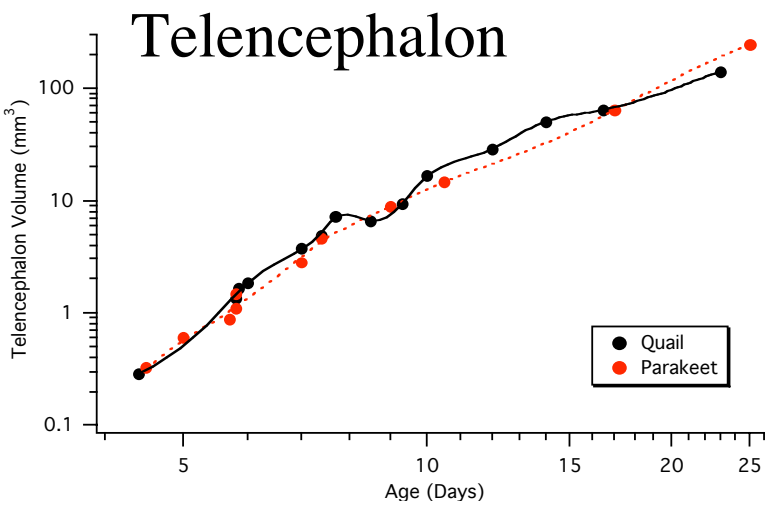
Parakeet Embryo at 6 days
Stage HH27,
Body Weight = 0.053 g

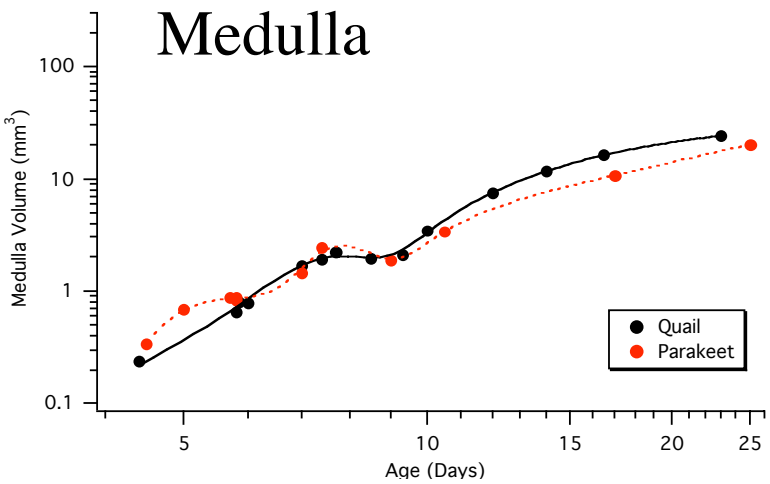


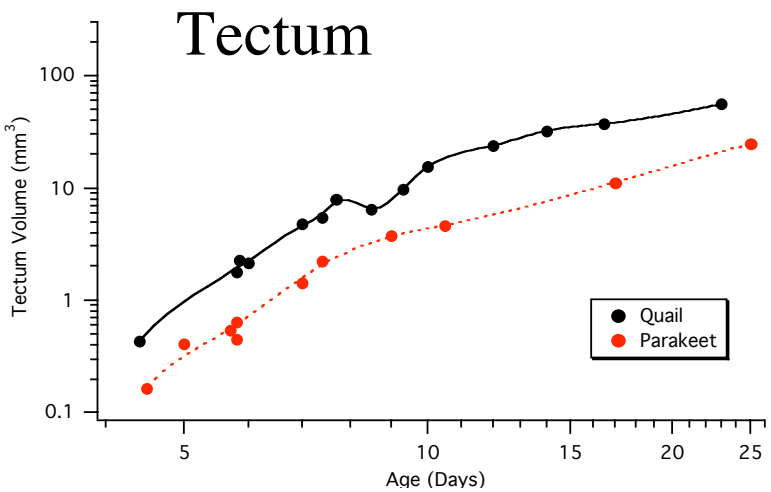


Brain region growth curves:

absolute volumes

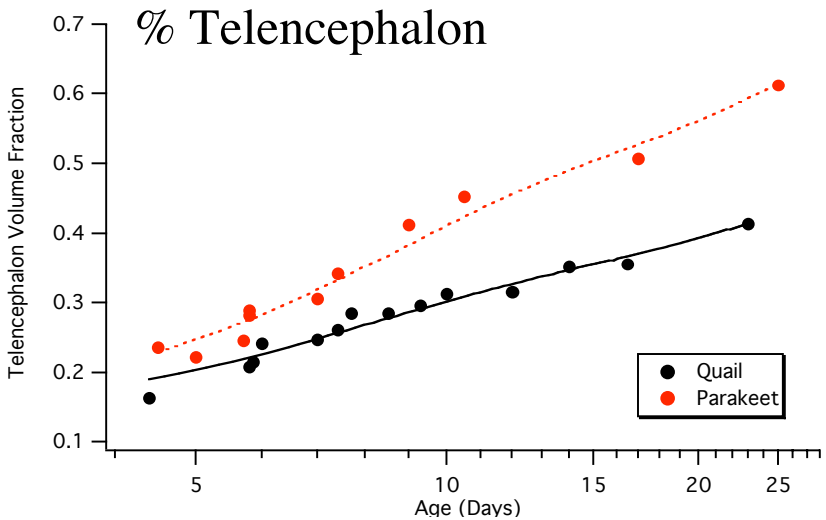


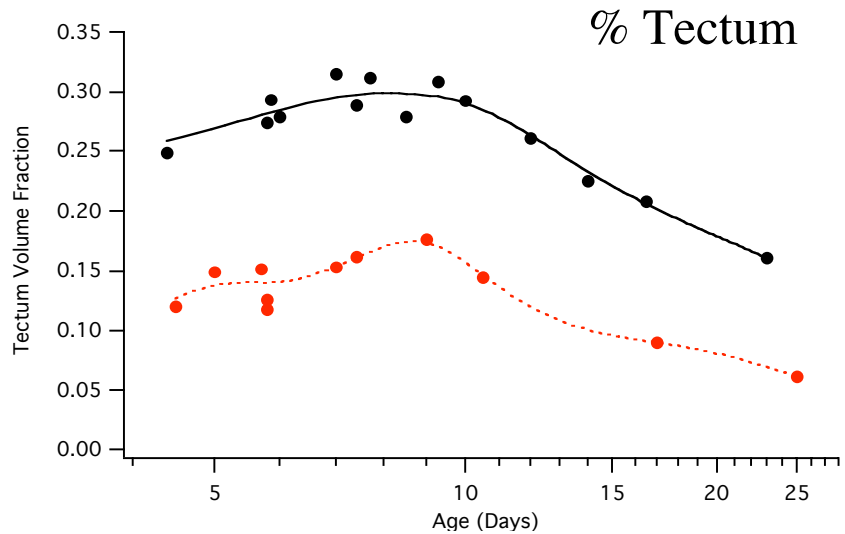


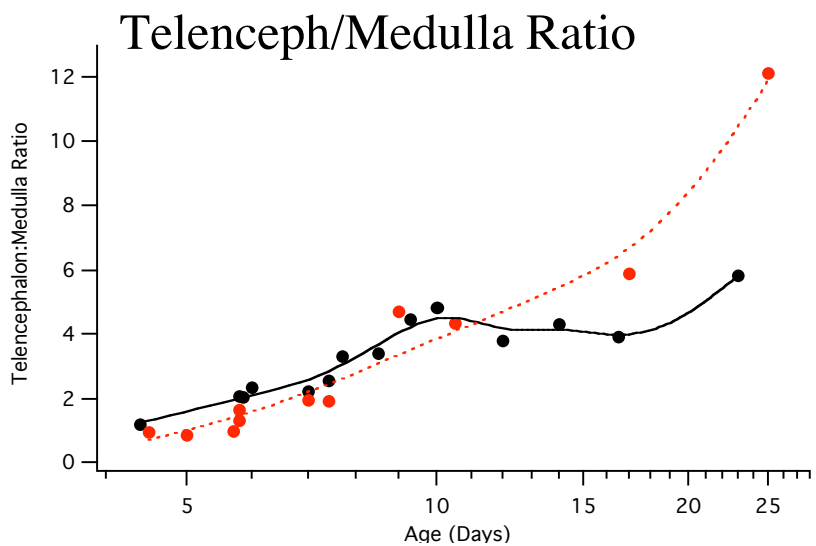


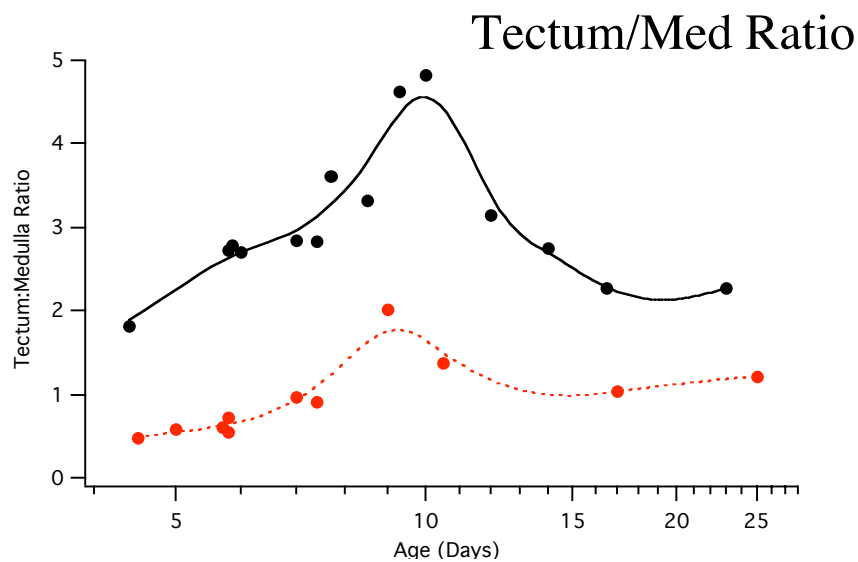
Brain region growth curves:

proportional volumes



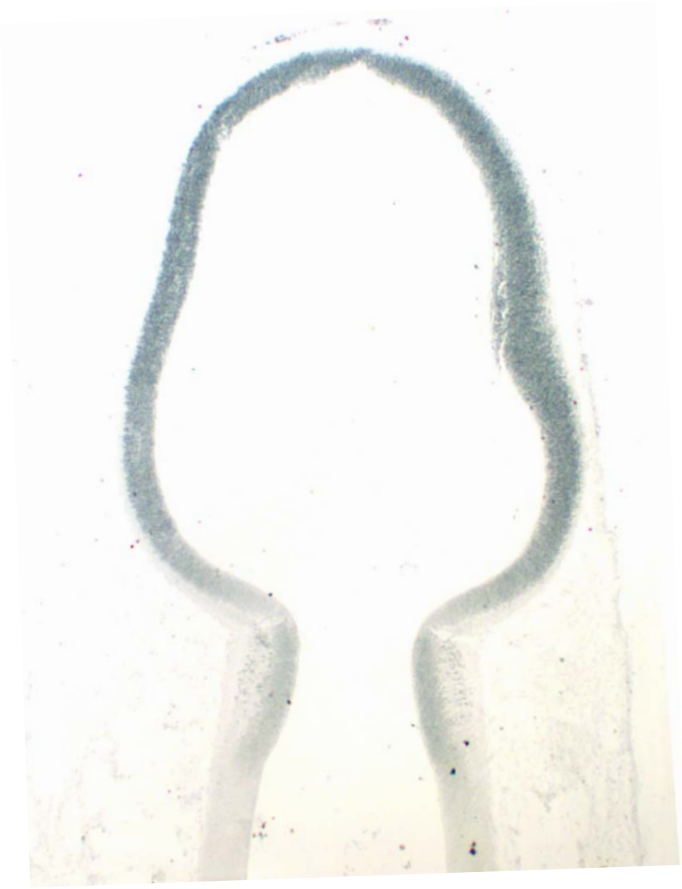






Molecular markers for tectum

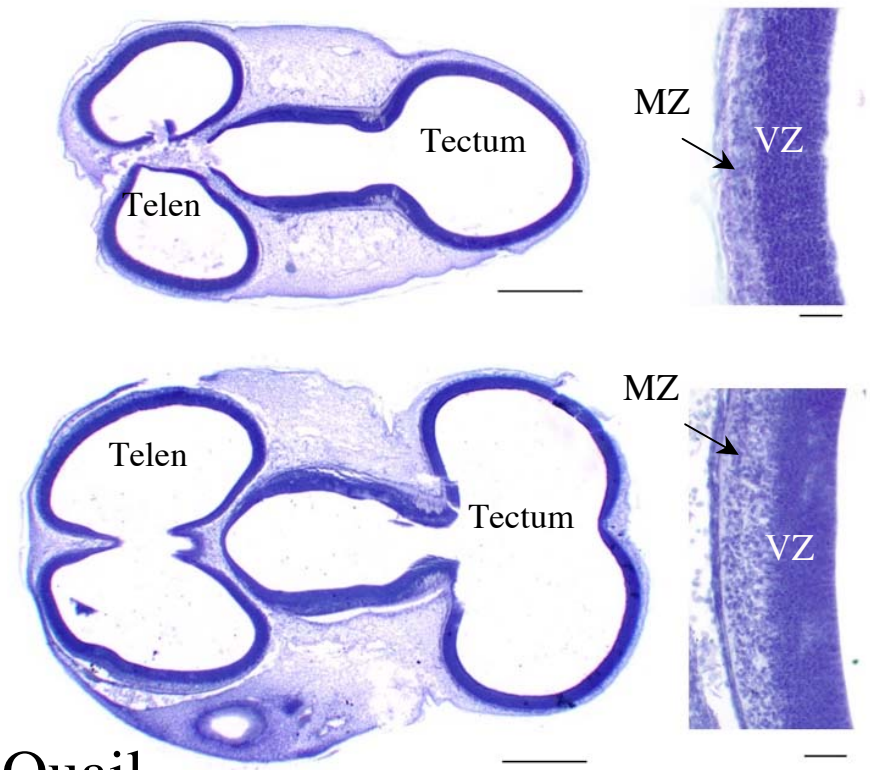
Meis2 in a quail



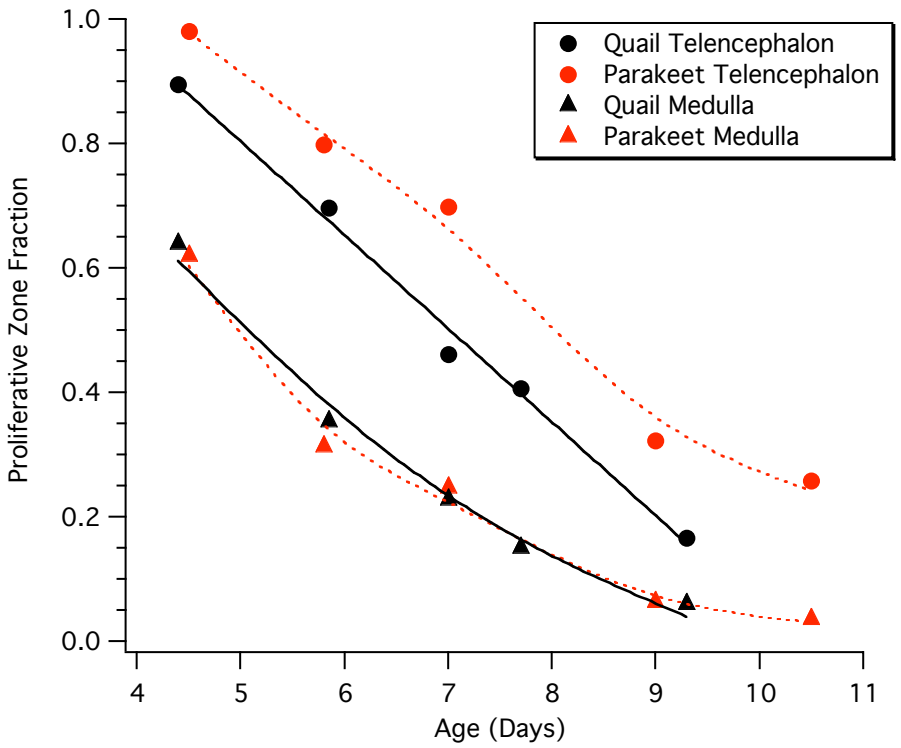
Pax7 in a parakeet
(younger than the quail at left)

Delayed Neurogenesis in Parakeet Telencephalon?

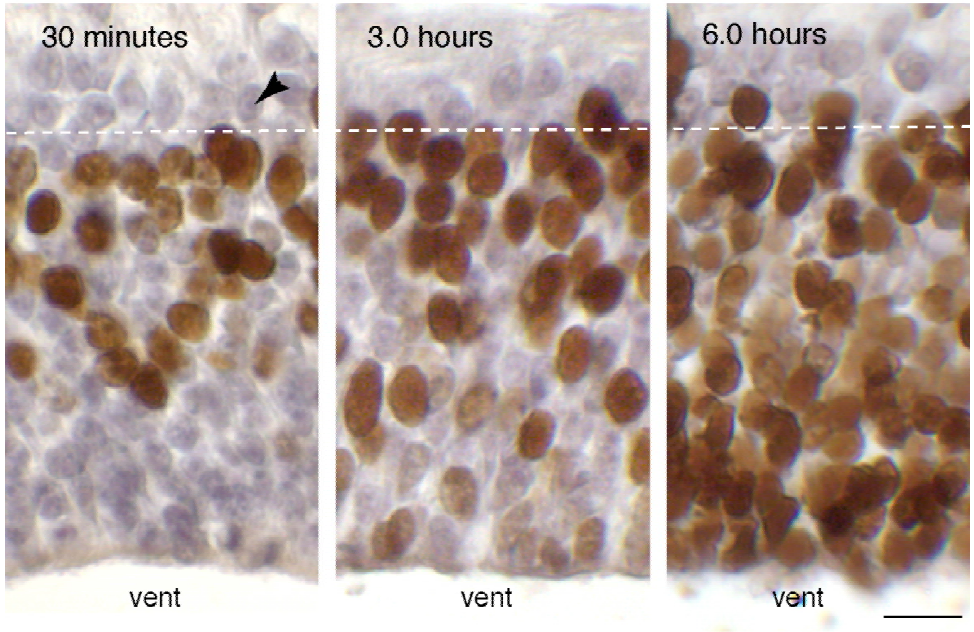
Parakeet

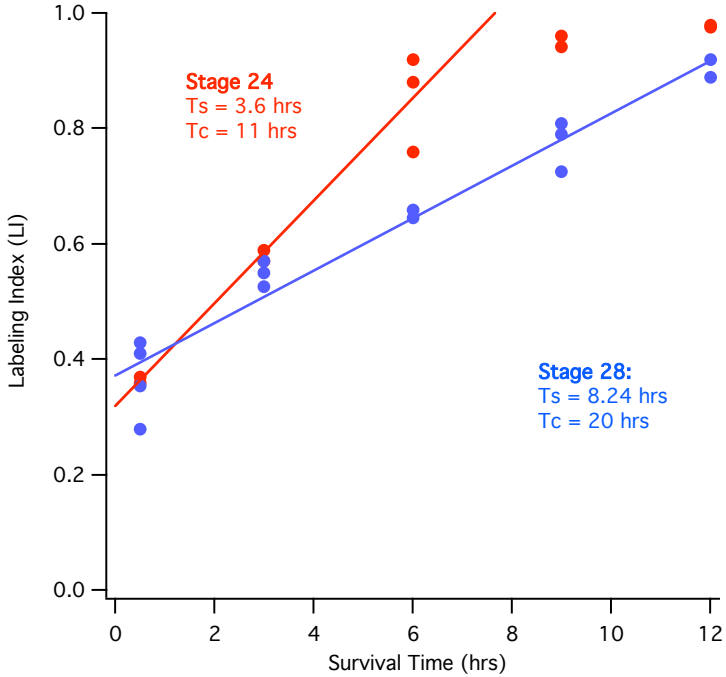


Quail



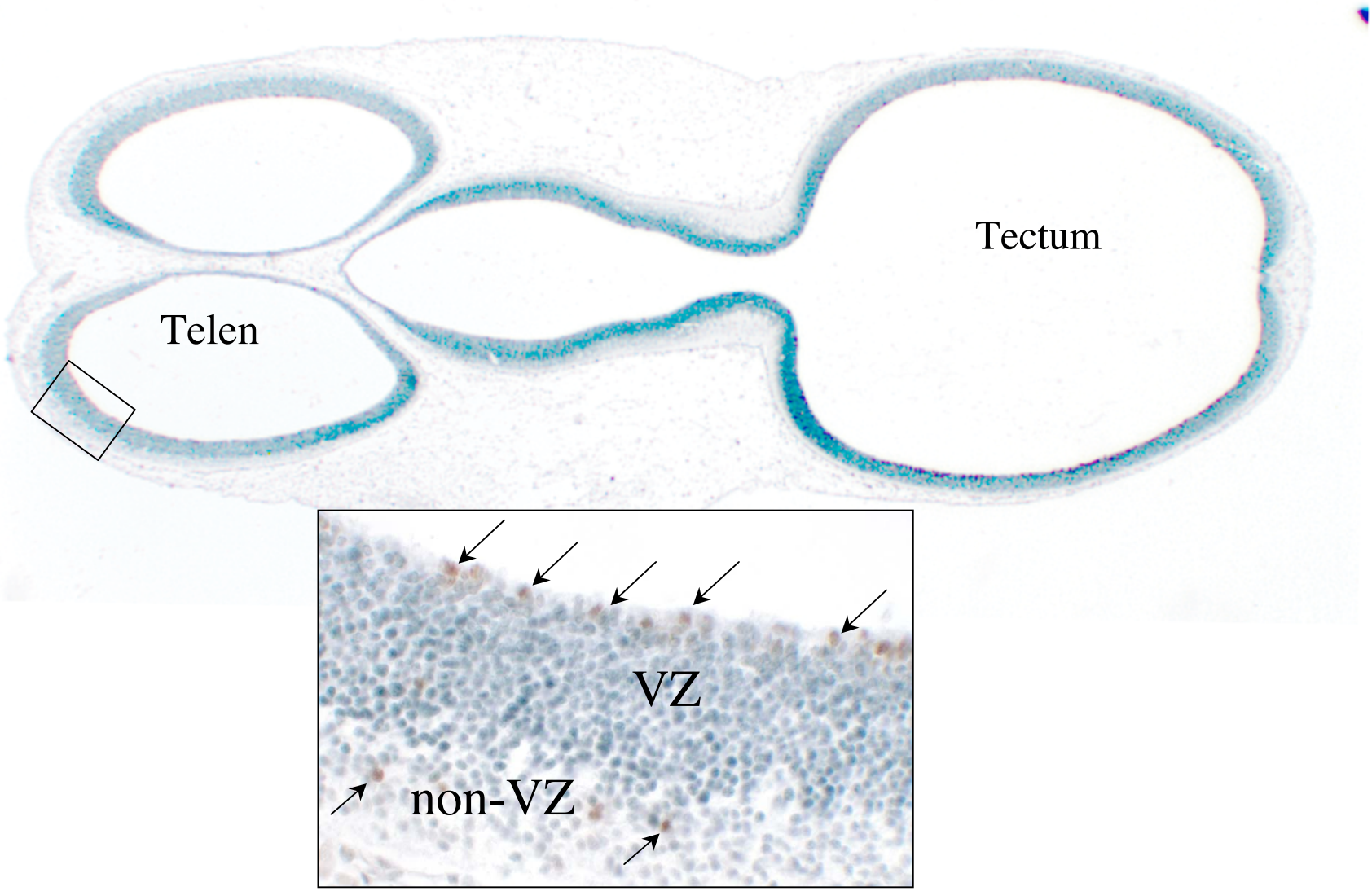
Measuring Cell Cycle Rates:
cumulative BrdU labeling





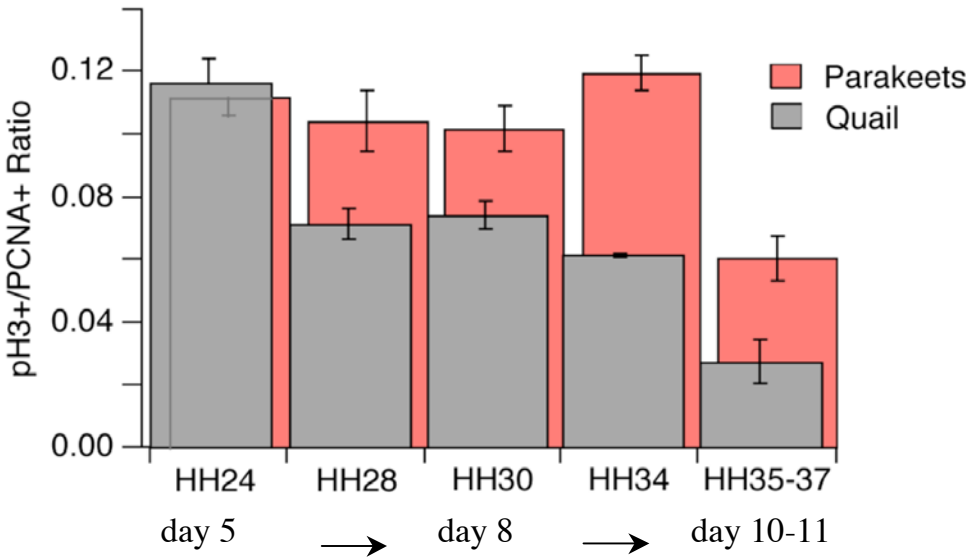
Relative Cell Cycle Rates:

pH3+/PCNA+ Ratios

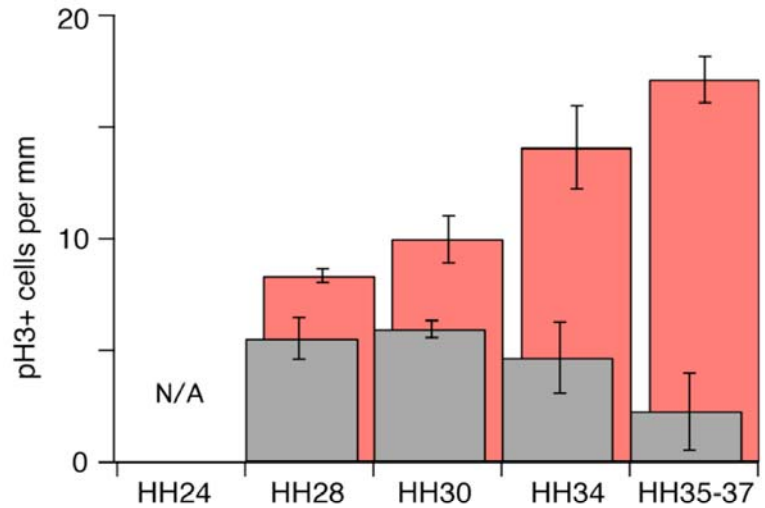


Species differences in telencephalic proliferation

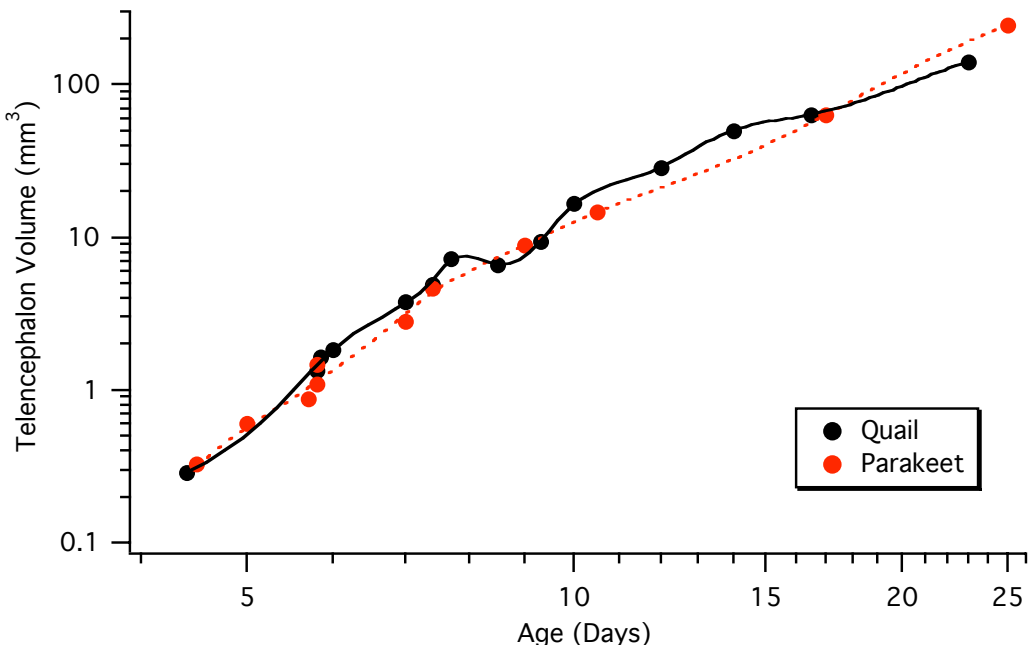
Telencephalic VZ



Telencephalic non-VZ

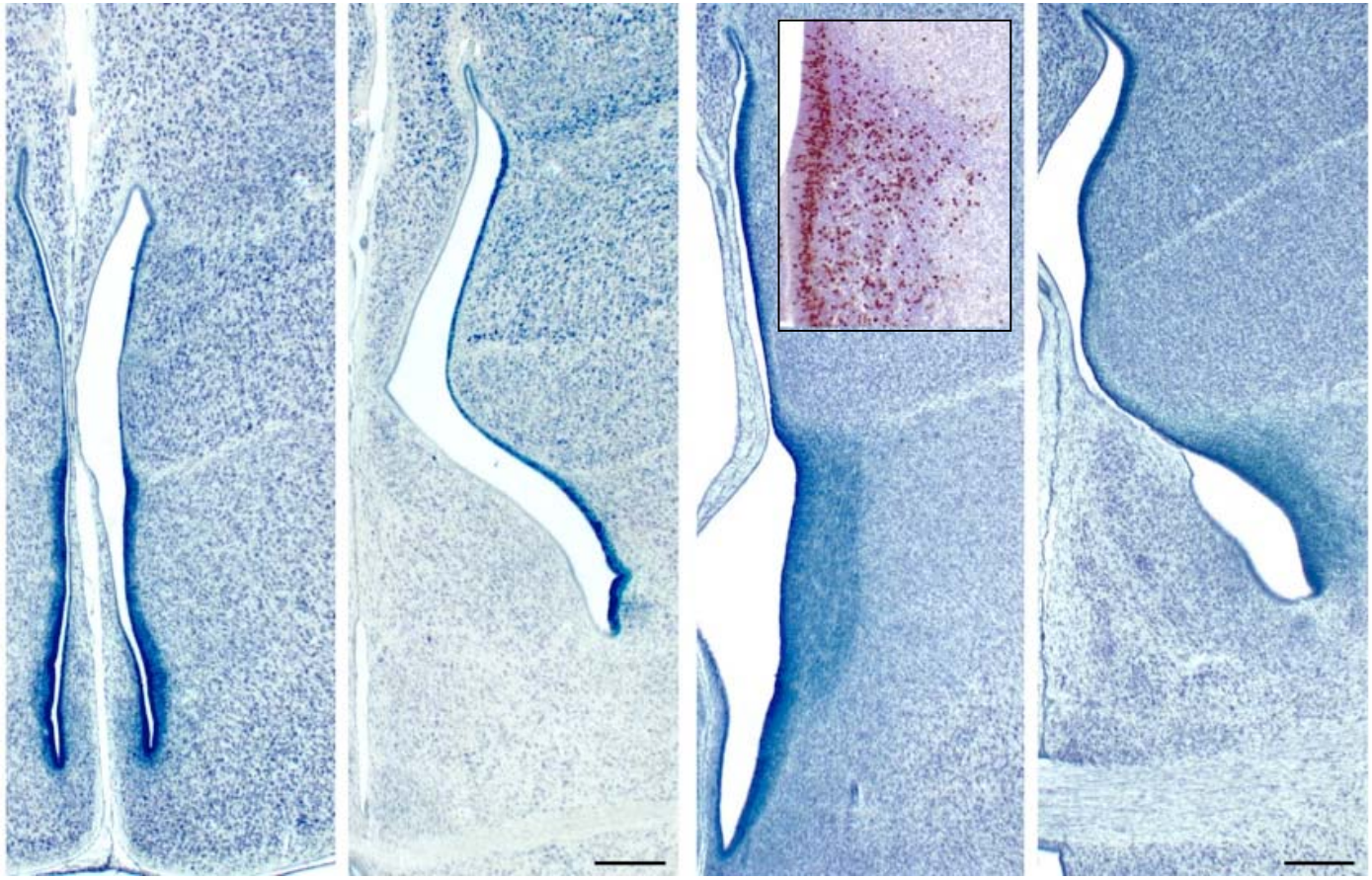


A Puzzle....



If telencephalic cells in parakeets cycle more quickly and exit the cell cycle later, why doesn't the telencephalon grow faster in parakeets than quail?

Higher Telencephalic Cell Densities in Parakeets?



Quail @ 23 days Parakeets @ 25 days

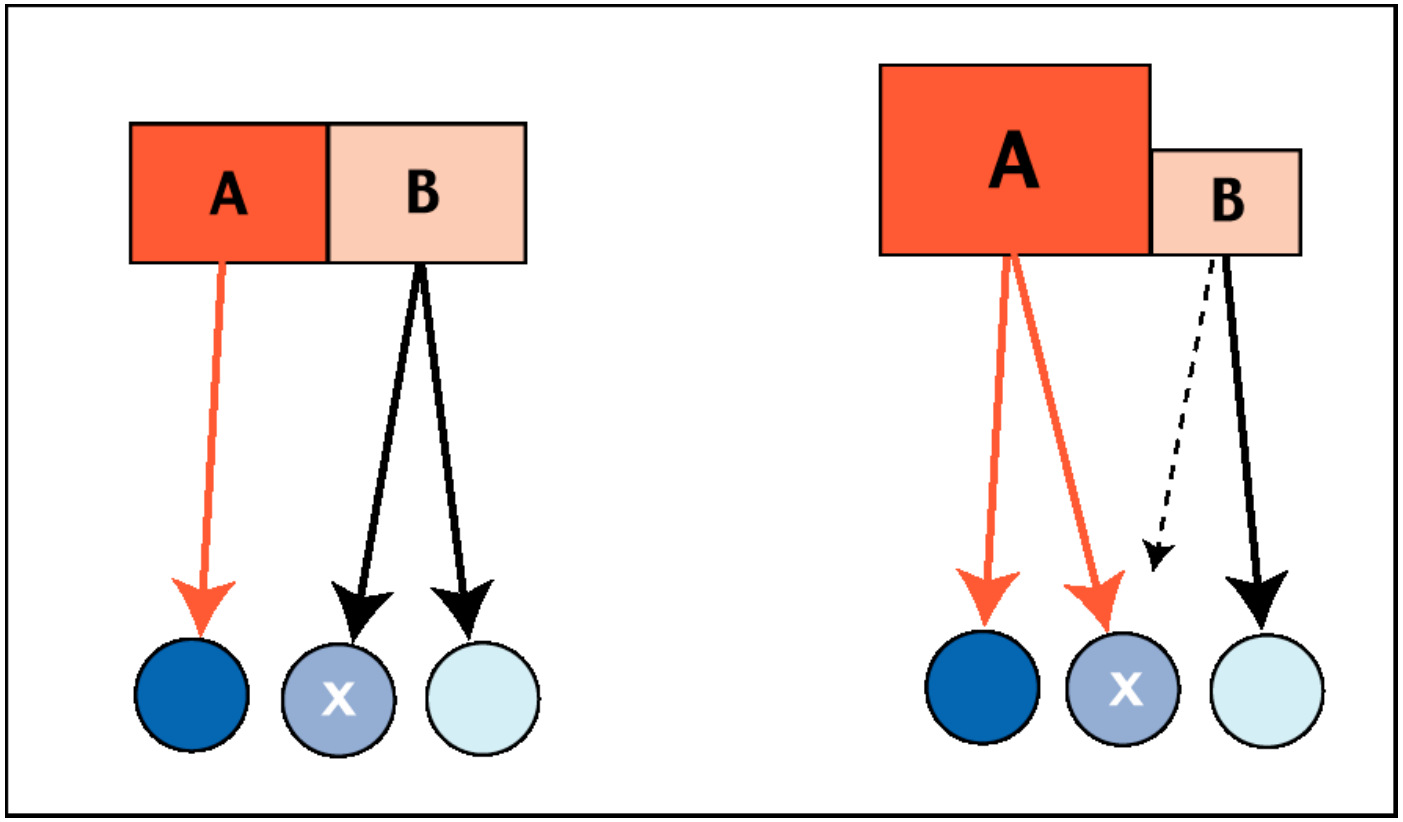
Findings

- Parakeets have an unusually small optic tectum throughout most of embryogenesis.

- Parakeets delay telencephalic neurogenesis relative to quail.

- Parakeets maintain high telencephalic cell cycle rates longer than quail do.

So what?



Do increases in proportional size cause increases in connectivity?