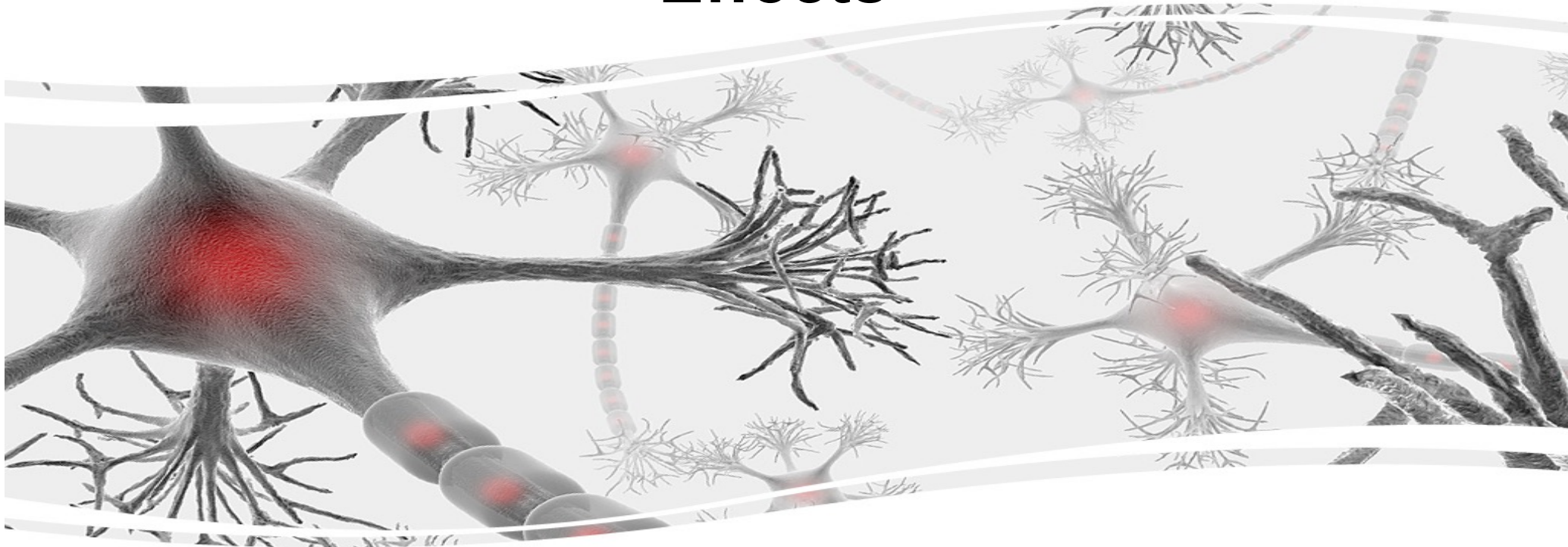


Cell Proliferation in the Septo-Hippocampal Pathway: Season, Lesion, and Species Effects



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OVERVIEW

- ❖ Avian Model & Food-Storing Behavior



- ❖ Septo-Hippocampal Pathway

 - ❖ Hippocampal Cell Proliferation & Traumatic Brain Injury (TBI)

- ❖ Injury-Induced Cell Proliferation

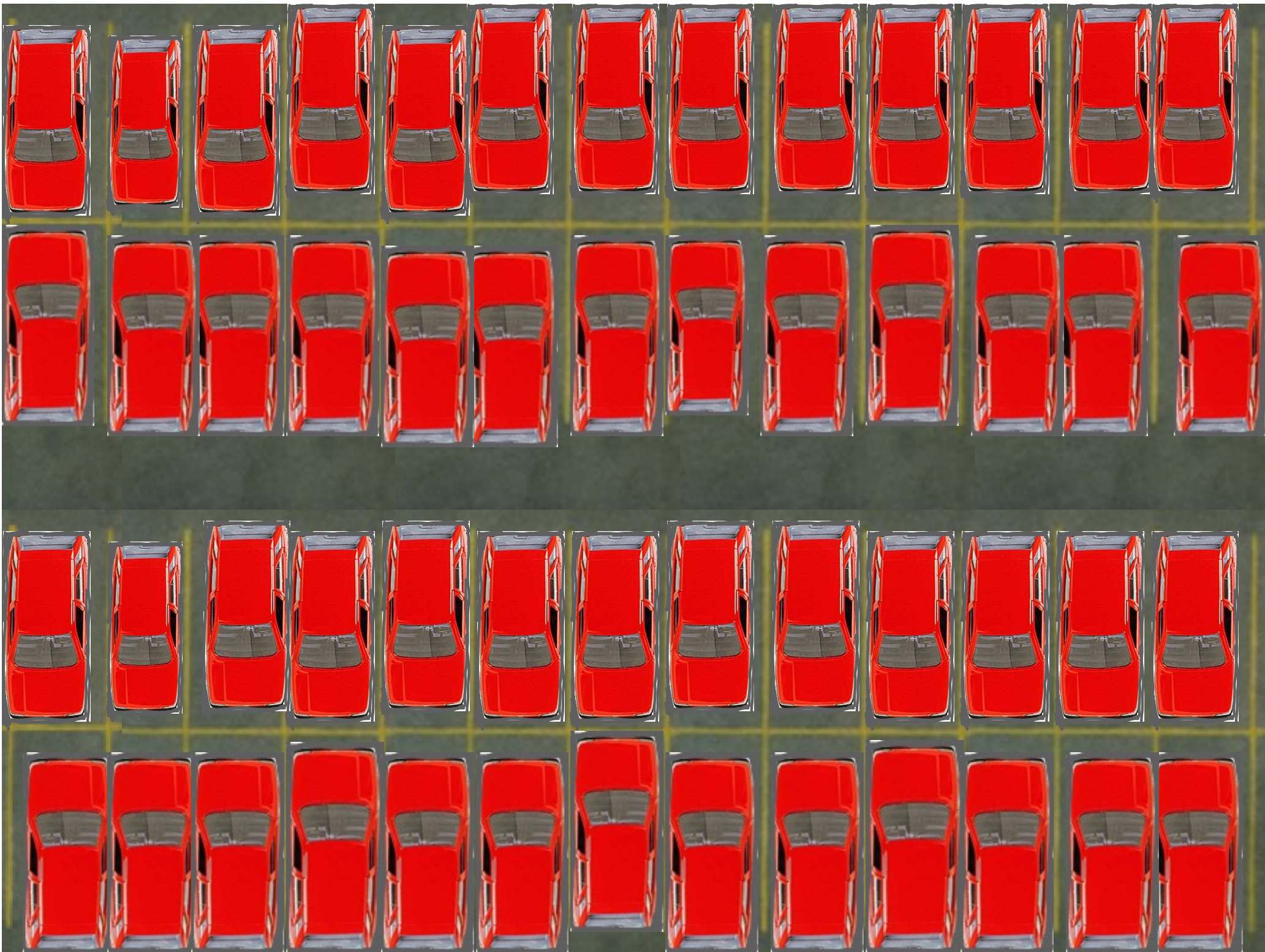
 - ❖ Hippocampus & Subventricular Zone (SVZ)

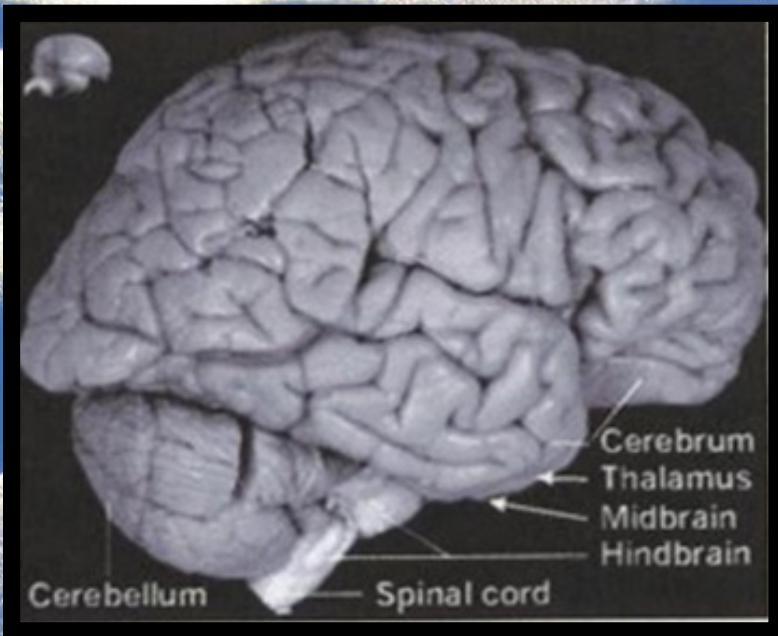
 - ❖ Septum

- ❖ Seasonal Changes in Cell Proliferation

- ❖ Future Directions







30,000 Seeds



9,000 separate locations

20km distances

9 month retention

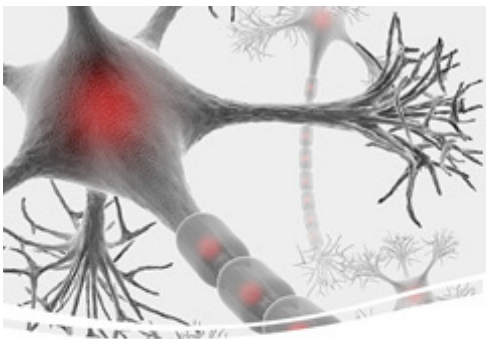


AVIAN FOOD-STORING

- ❖ Seasonal behavior
- ❖ Relies on an intact Hippocampus
- ❖ Storsers outperform nonstorsers on tasks of spatial memory
- ❖ Storsers have larger hippocampal and septal volumes as well as more hippocampal neurogenesis than non-storsers
- ❖ Storsers have larger hippocampal and septal volumes during the fall compared to the spring



SEPTO-HIPPOCAMPAL PATHWAY

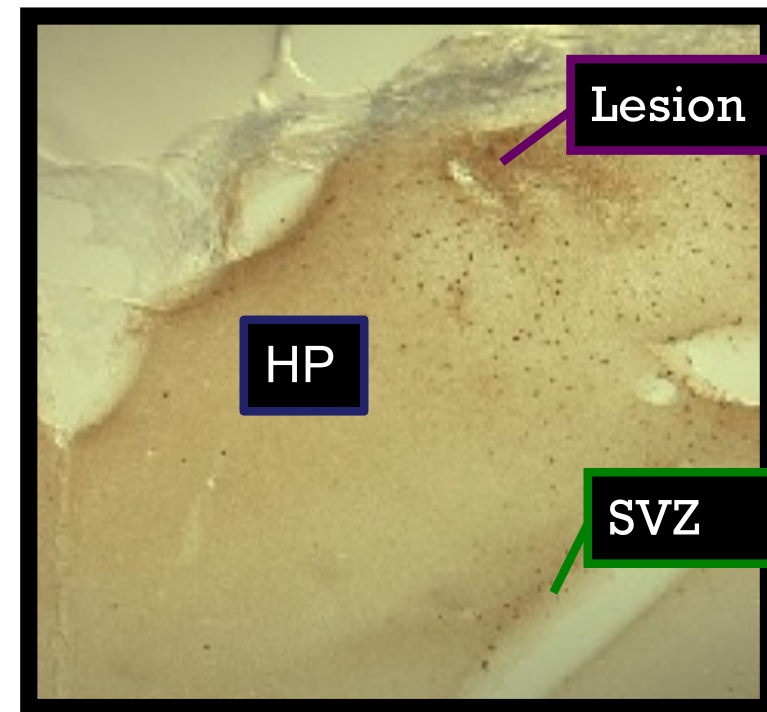


❖ Hippocampus shares reciprocal, bilateral connections to Septum – both regions involved in food-storing

❖ Mammals: Septal injury reduces hippocampal neurogenesis

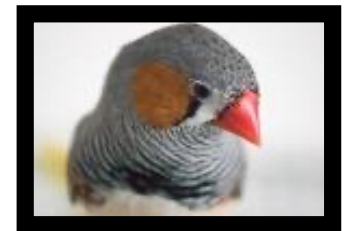
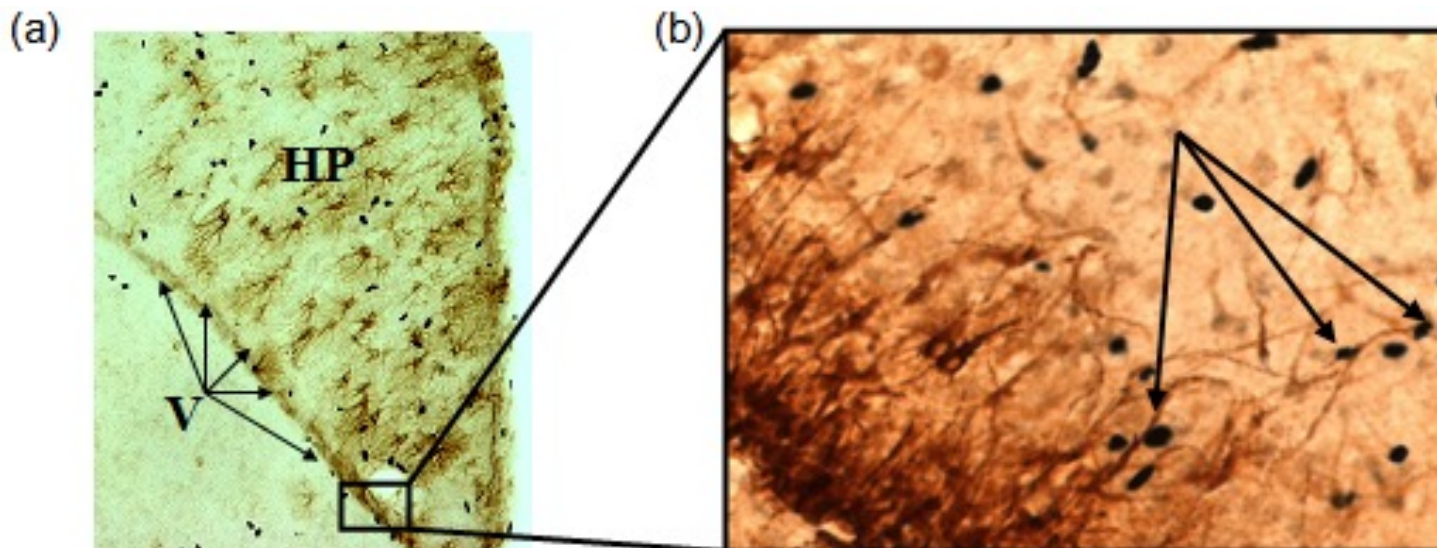
❖ Zebra Finches: Hippocampal **injury** results in cell proliferation in the **hippocampus** & adjacent stem cell rich **subventricular zone (SVZ)**; Lee et al., 2007)

❖ New cells found in Septum
(Lucas & Lee, 2009)



SEPTO-HIPPOCAMPAL PATHWAY

- ❖ Zebra Finches: Hippocampal injury results in upregulation of aromatase in reactive astrocytes & glia (Peterson et al., 2004; 2007; Lee et al., 2007)
- ❖ Somas of adult radial cells are anchored in SVZ & their processes extend out toward the injury



(Peterson et al., 2004)

SPECIES-SPECIFIC INJURY-INDUCED CELL PROLIFERATION IN THE HIPPOCAMPUS & SVZ

❖ Effect of hippocampal injury to storers during fall food-storing season?

❖ Law et al. (2009):



❖ Examined innate & injury-induced cell proliferation in wild-caught food-storing black-capped chickadees & non-storing dark-eyed juncos during the fall at the CSC

❖ Birds received either no lesion or a unilateral lesion to the right hippocampus

❖ 24 hours later, all birds received an injection of the mitotic marker BrdU

❖ 7 days later, all birds were perfused

❖ DV: Density of BrdU-immunoreactive cells (cells/mm²) in the hippocampus & SVZ



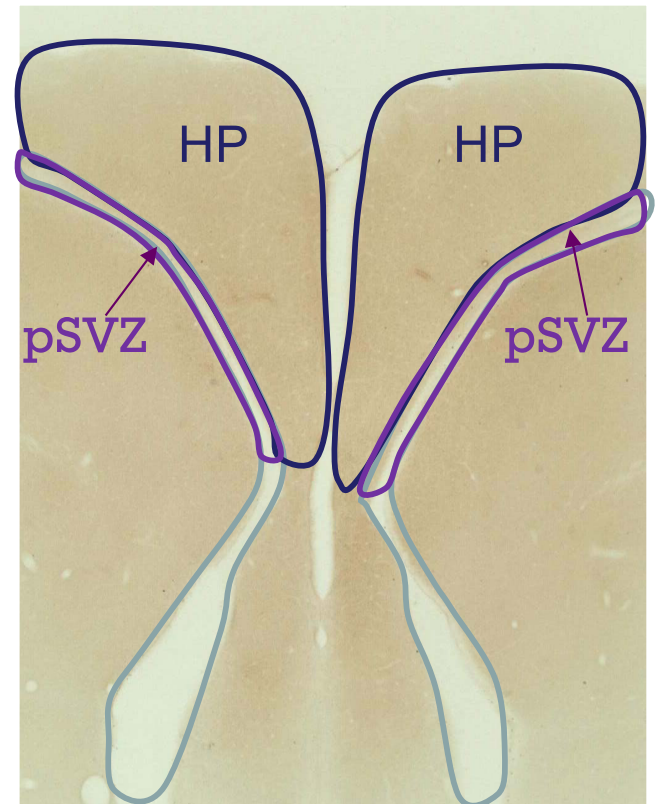
SPECIES-SPECIFIC INJURY-INDUCED CELL PROLIFERATION IN THE HIPPOCAMPUS & SVZ

❖ BrdU-IR cells were counted in the **hippocampus & SVZ**

❖ **SVZ** divided based on proximity to hippocampus

❖ **Proximal SVZ (pSVZ):**
Lies adjacent to hippocampus

❖ **Distal SVZ (dSVZ):**
Nonadjacent to hippocampus



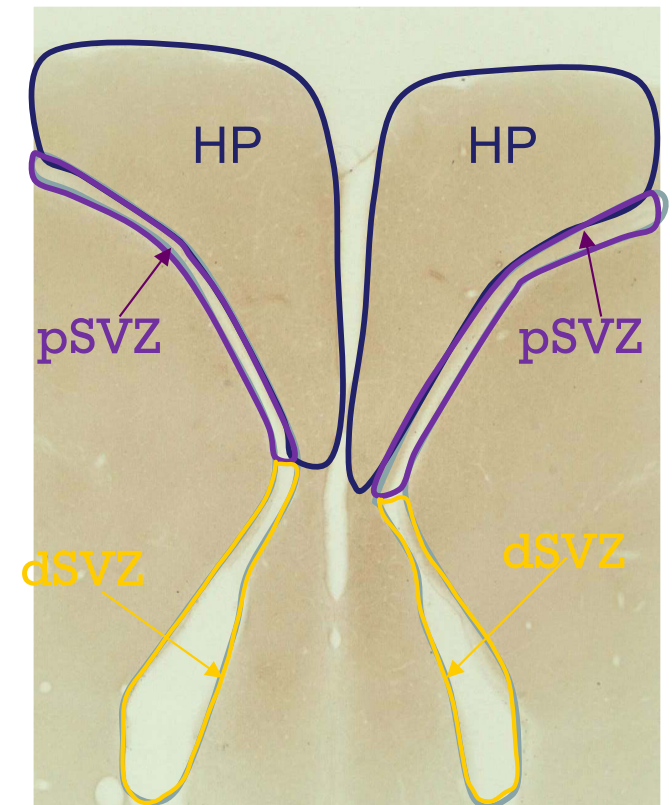
SPECIES-SPECIFIC INJURY-INDUCED CELL PROLIFERATION IN THE HIPPOCAMPUS & SVZ

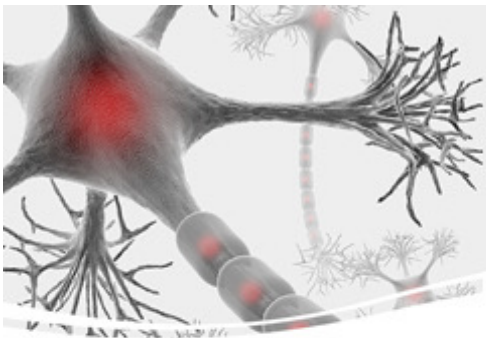
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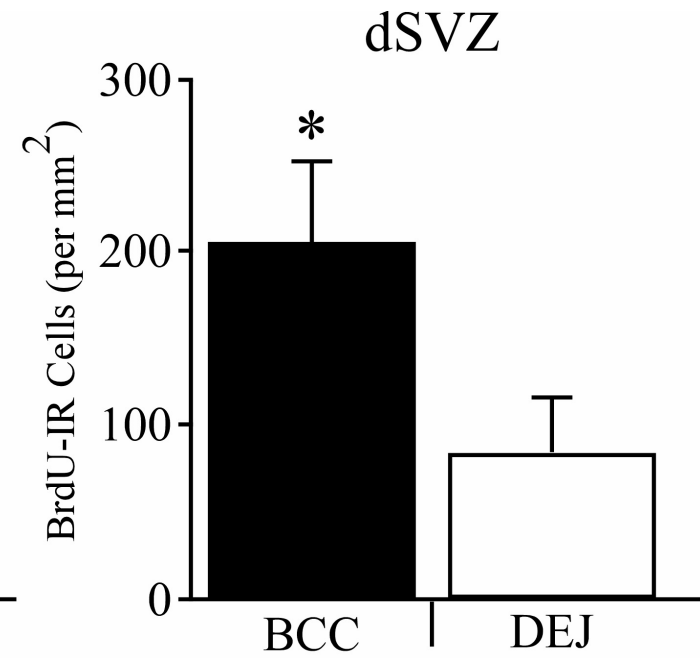
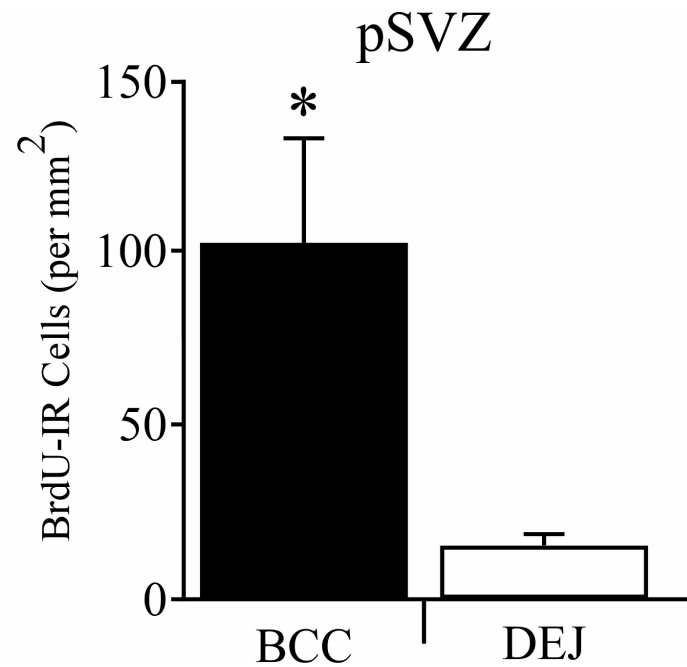
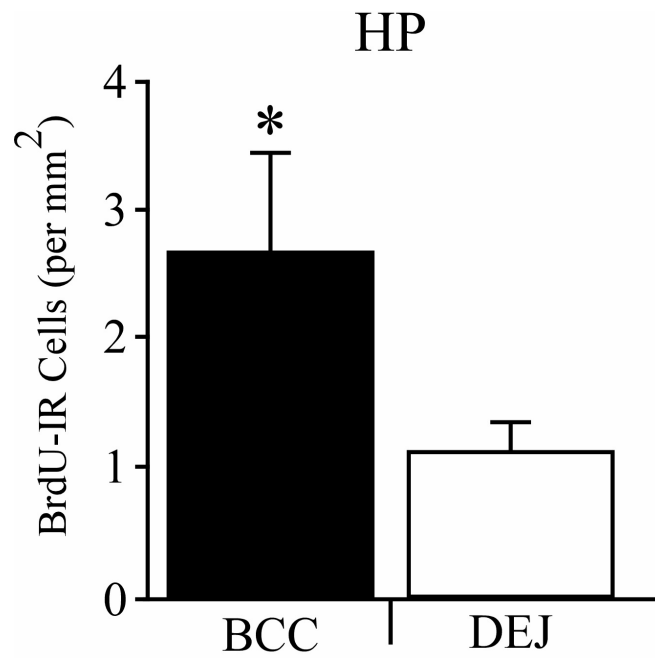
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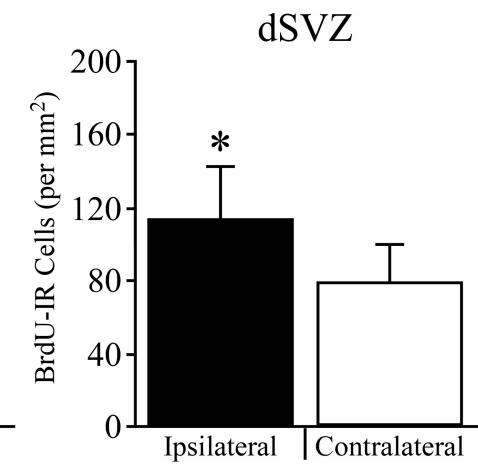
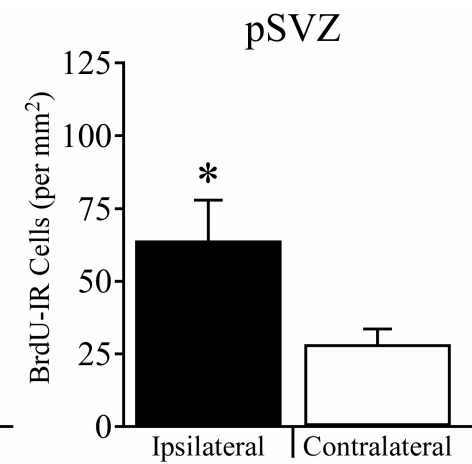
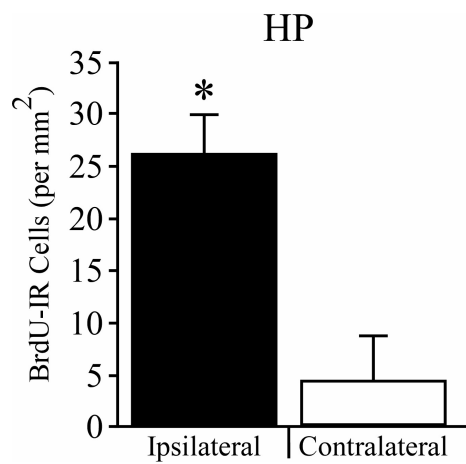
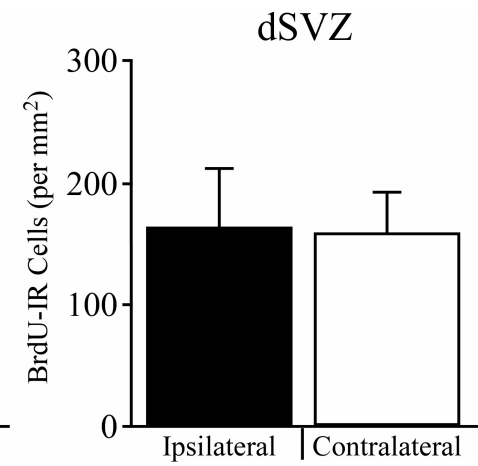
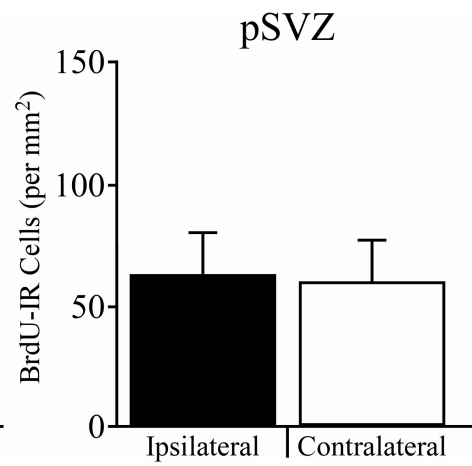
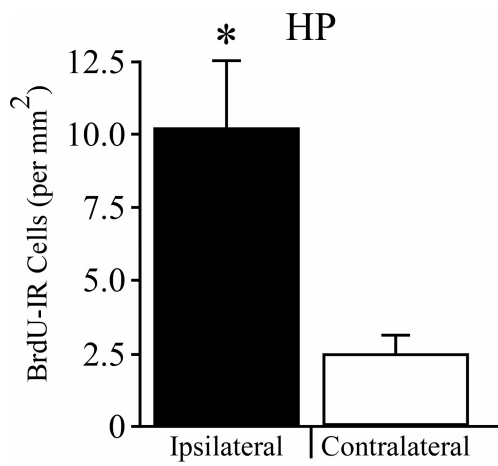




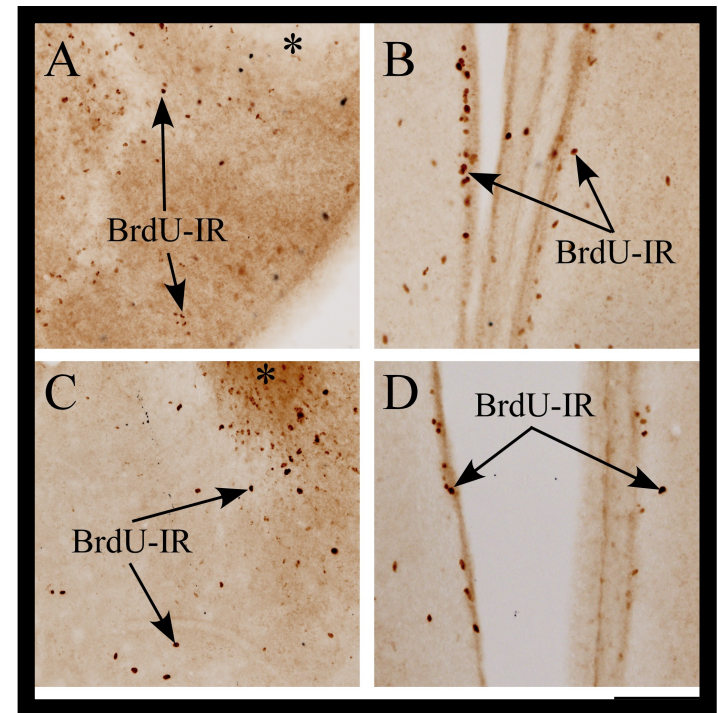
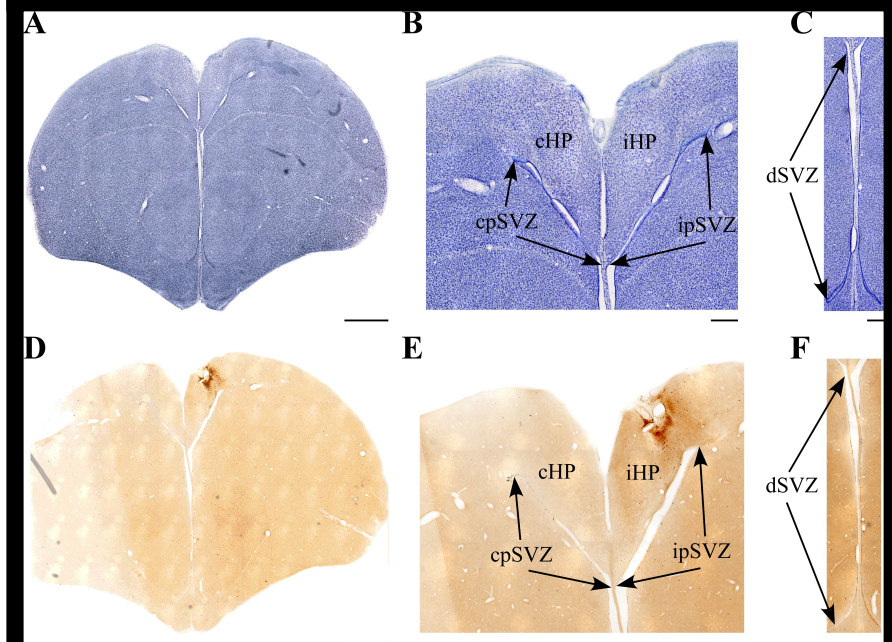
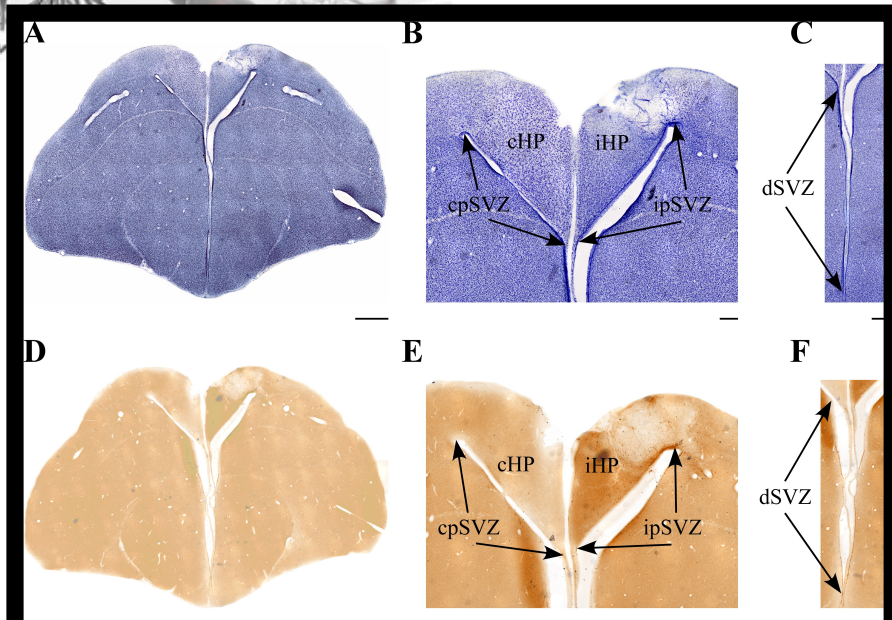
INNATE CELL PROLIFERATION: CHICKADEE > JUNCO



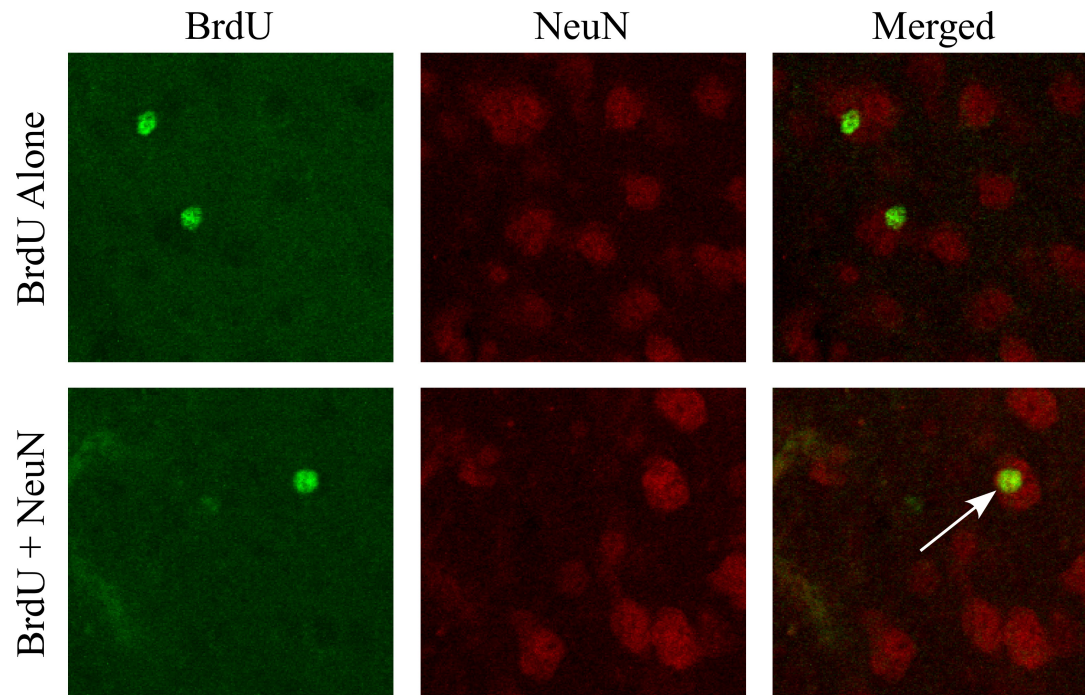
INJURY-INDUCED CELL PROLIFERATION: JUNCO > CHICKADEE



INJURY-INDUCED CELL PROLIFERATION: JUNCO > CHICKADEE



INJURY-INDUCED NEUROGENESIS: CHICKADEE > JUNCO



Species	Brain Region		
	HP (%)	pSVZ (%)	dSVZ (%)
BCC	37	7	<1
DEJ	17	0	0

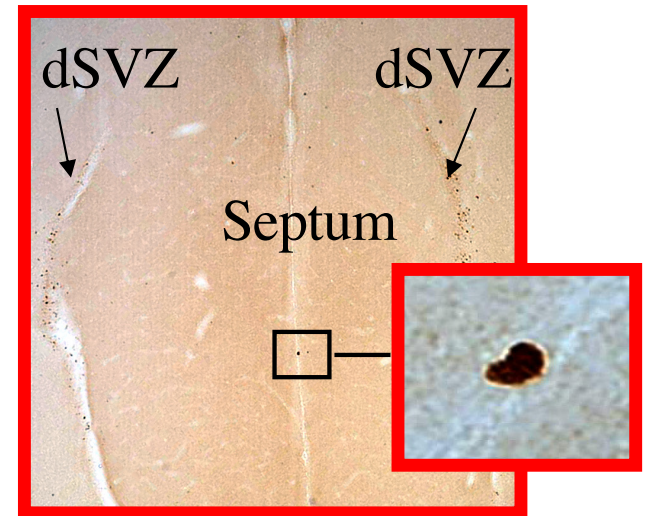
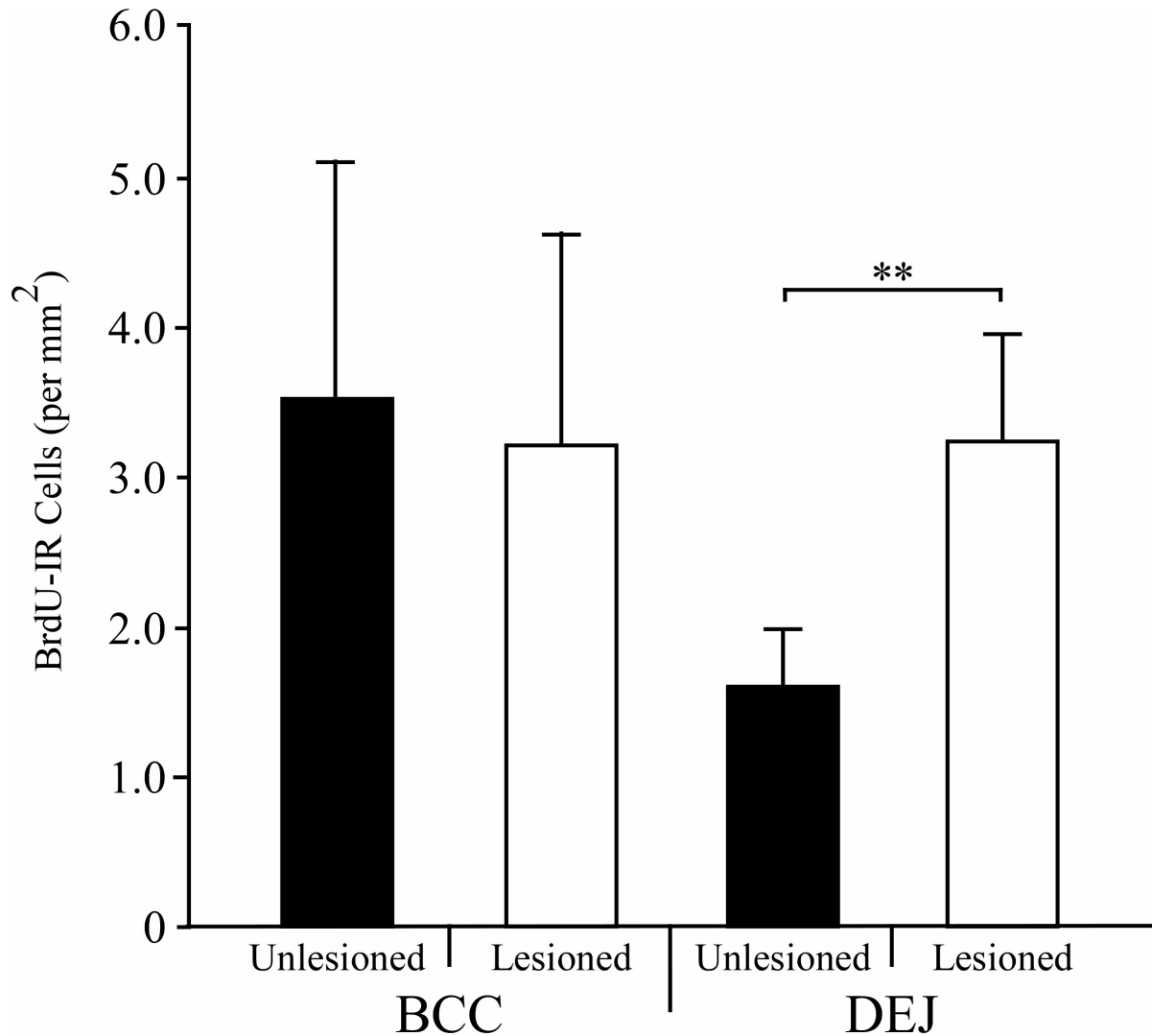


SPECIES-SPECIFIC INJURY-INDUCED CELL PROLIFERATION IN THE SEPTUM

- ❖ Septal response following hippocampal injury?
- ❖ Gardner et al. (in prep):
 - ❖ Examined injury-induced cell proliferation in wild-caught storing chickadees & non-storing juncos during the fall at the CSC
 - ❖ Same birds used by Law et al. (2009)
 - ❖ DV: Density of BrdU-IR cells (cells/mm²) in the Septum



INJURY-INDUCED CELL PROLIFERATION: JUNCO > CHICKADEE

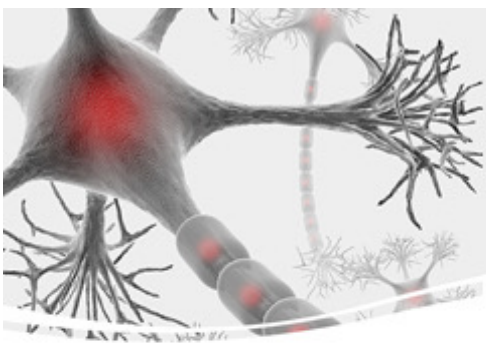




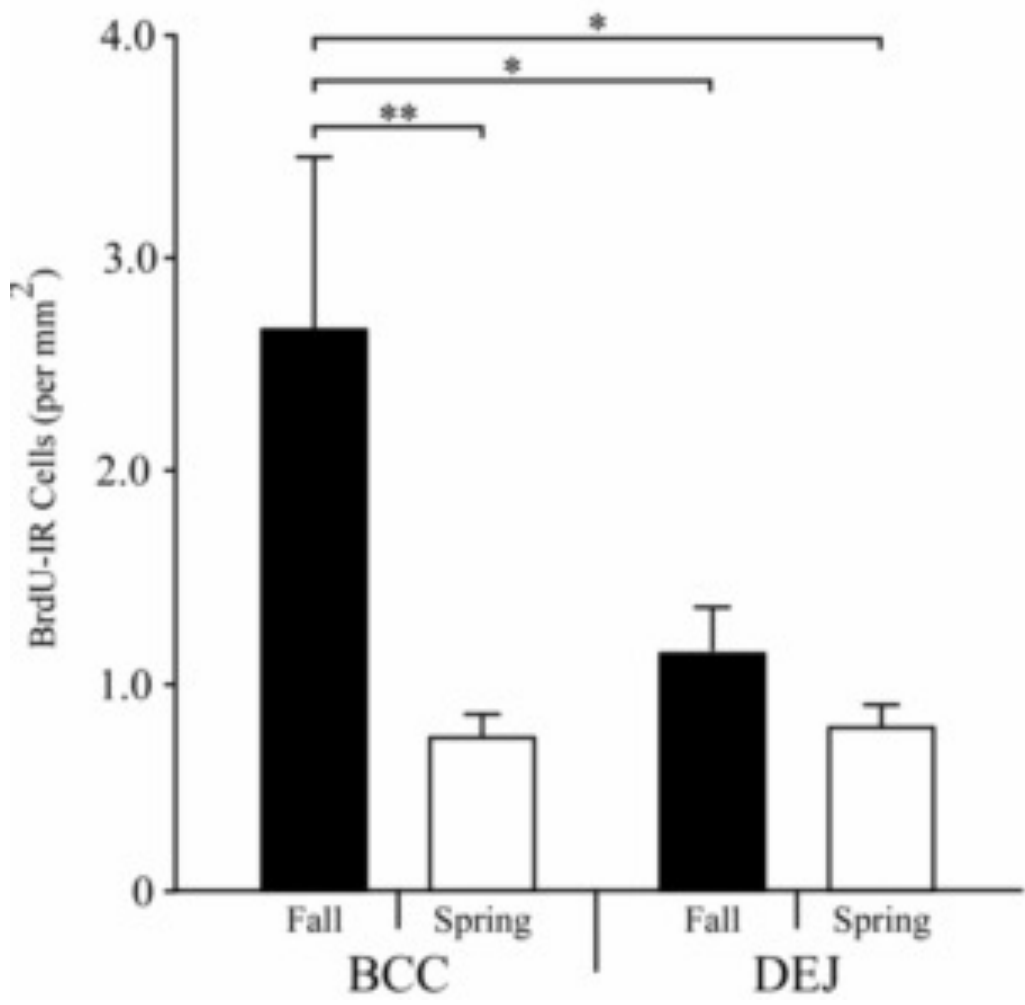
SEASONAL CELL PROLIFERATION

- ❖ Seasonal fluctuations in septal or SVZ cell proliferation?
- ❖ Gardner et al. (in prep):
 - ❖ Examined innate (unlesioned) cell proliferation in wild-caught storing chickadees & non-storing juncos during the fall & spring at the CSC
 - ❖ 48 hours after capture, all birds received an injection BrdU
 - ❖ 7 days later, all birds were perfused
 - ❖ DV: Density of BrdU-IR cells (cells/mm²) in the hippocampus, septum, pSVZ, & dSVZ

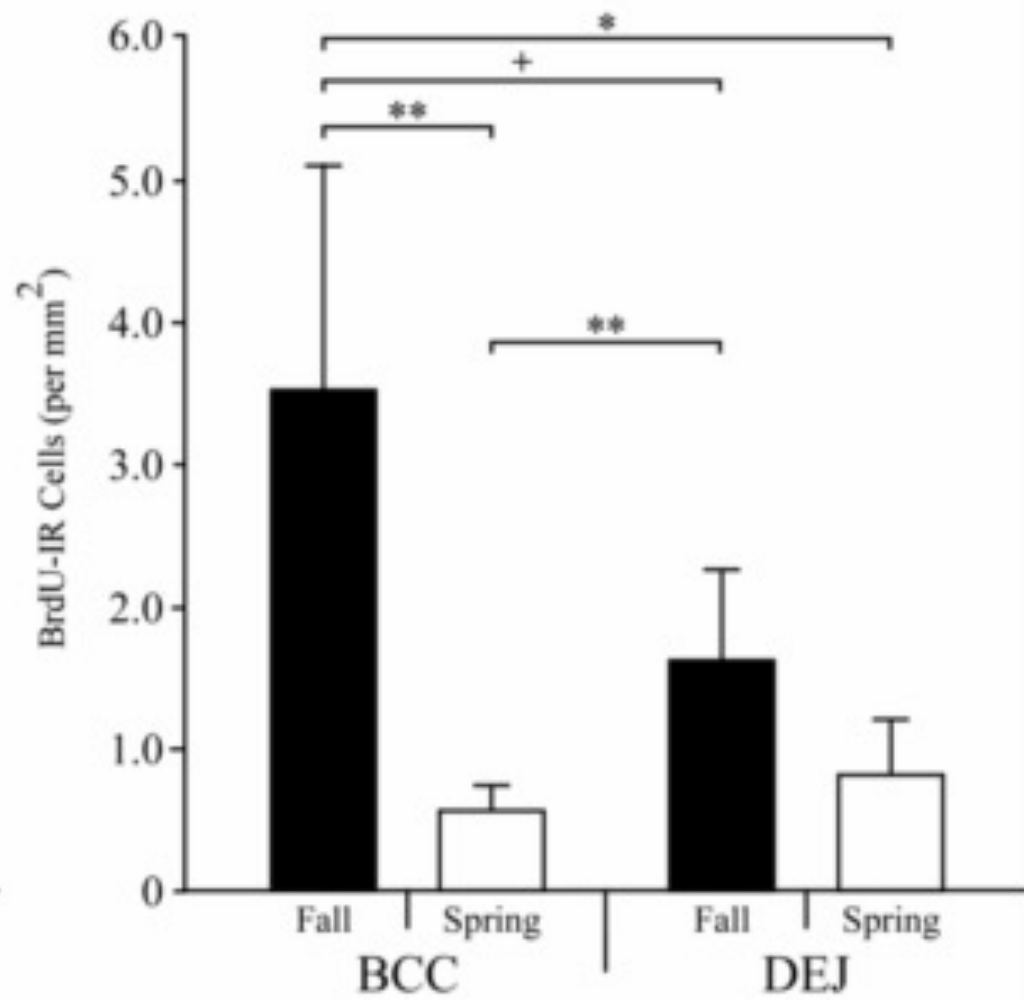
CHICKADEE HIPPOCAMPUS & SEPTUM FALL > SPRING

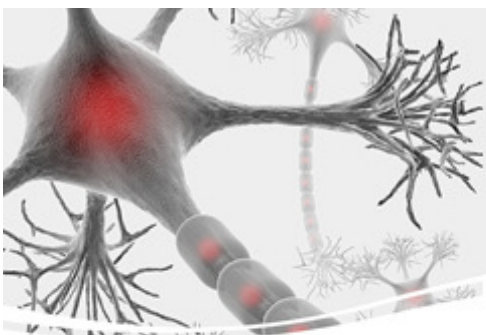


Hippocampus



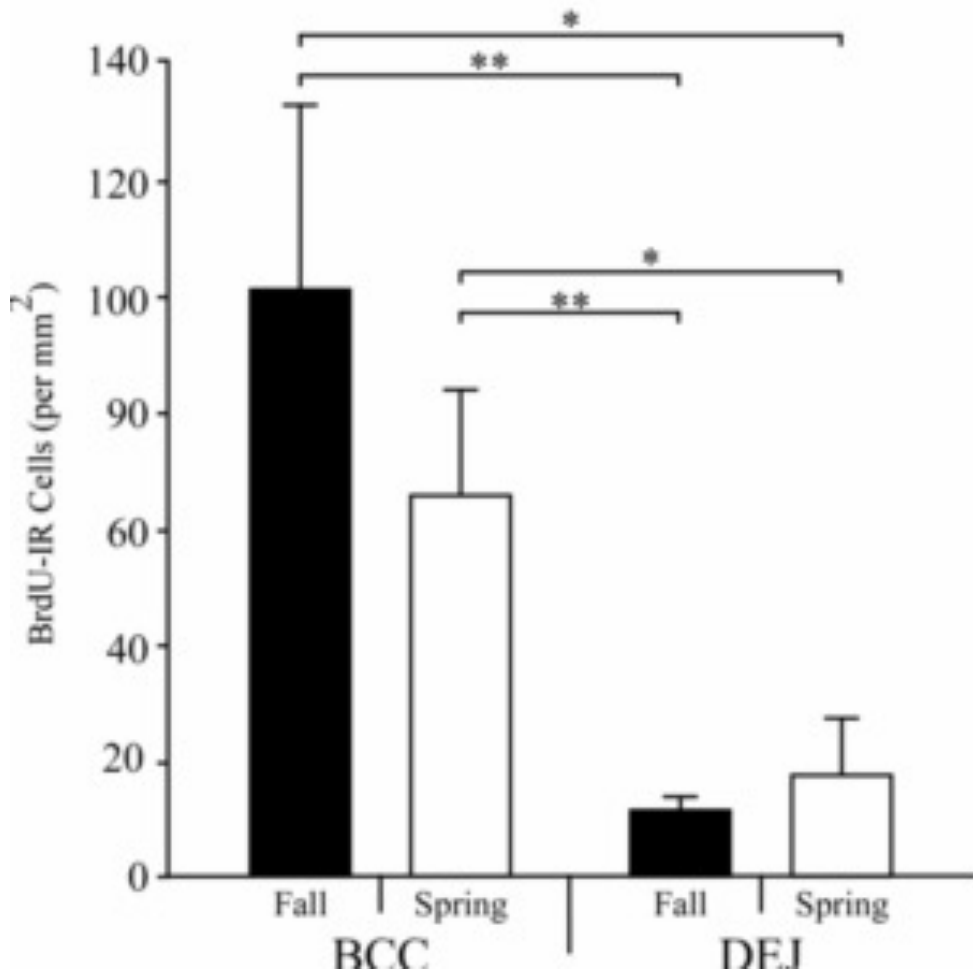
Septum



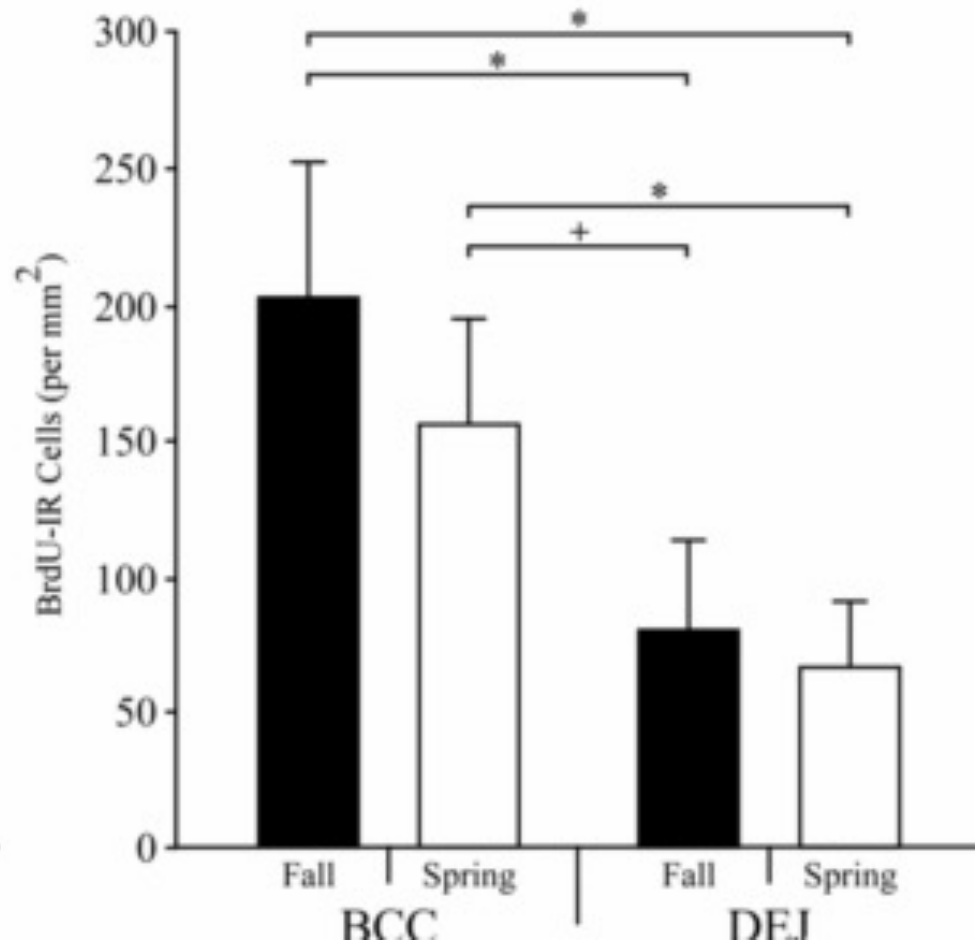


NO SEASONAL CHANGES IN SVZ

Proximal Subventricular Zone



Distal Subventricular Zone





SUMMARY OF MAIN FINDINGS

- ❖ Both the hippocampus & septum have peak rates of cell proliferation during the fall in chickadees but not juncos
- ❖ There are no seasonal effects in the SVZ in either species
- ❖ Lesioned chickadees only show injury-induced cell proliferation in the hippocampus
- ❖ Lesioned juncos show injury-induced cell proliferation in the hippocampus, septum, pSVZ, & dSVZ (similar to zebra finches)
- ❖ Lesioned chickadees had fewer newly born hippocampal cells following injury compared to juncos
- ❖ Lesioned chickadees had a higher percentage of newly born neurons compared to juncos



INTERPRETATIONS: WHAT'S UP CHICKADEE?

❖ Innate cell proliferation:

- ❖ Is enhanced in storers, especially during the fall?
- ❖ Selective advantage in the brain designed to meet the cognitive demands of food-storing?

❖ Injury-Induced cell proliferation:

- ❖ Spread of injury restricted in storers?
- ❖ Storers demonstrate a much faster cellular turnover than nonstorers?



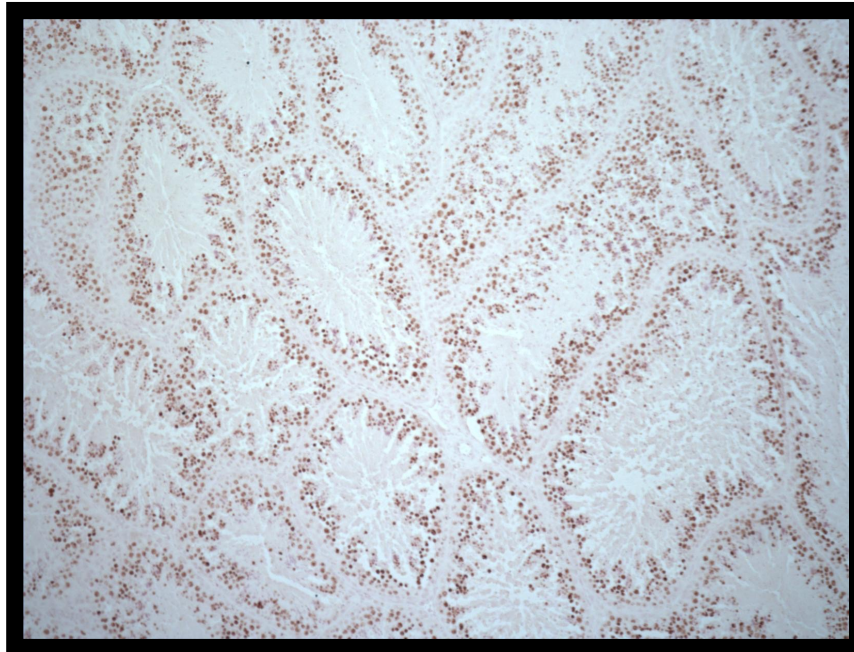
FUTURE DIRECTIONS

- ❖ Do food-storing birds differ from non-storing birds in the speed of cellular turnover following brain injury?
- ❖ Our current project will test the temporal characteristics of cell division by examining injury-induced cell proliferation by varying the time between injury, mitotic labeling, & survival

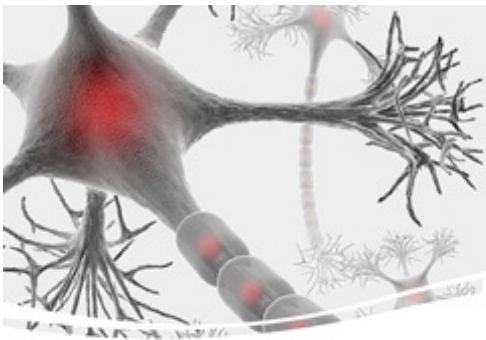


FUTURE DIRECTIONS

- ❖ Are there seasonal differences in response to hippocampal injury?
- ❖ Does food-storing behavior lead to a reproductive advantage?
 - ❖ Our ongoing project compares the timing of gonadal recrudescence & regression between storsers & non-storsers



THANKS TO:



Lee Lab @ CSULB: (past & present)

- * Dr. Diane W. Lee
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- * Dr. Tim Allen (not pictured)
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Emily Hahn

- * Matt Law
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Mary Ngo

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- * Katie Mitterling

Young Lab @ CSULB:

- * Dr. Kelly Young

* Involved in this project

FUTURE DIRECTIONS

