Cortical projections to the primate pulvinar's two retinotopic maps are distinct

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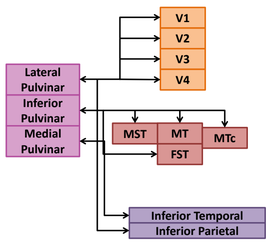
Introduction

The pulvinar complex reciprocally projects throughout cortex

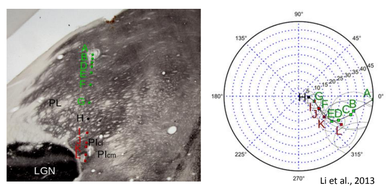


Adapted from Bridge et al., 2016

The **pulvinar** contains a vast number of reciprocal projections throughout cortex[2]. The **lateral** and **inferior** subdivisions of this thalamic complex are known to be involved with **visual processing**[3] in some capacity but the exact functionality of these areas remain an open question.

The visual pulvinar is retinotopically organized into two mirrored maps

As an electrode descends through the **visual pulvinar**, a curious pattern emerges: receptive fields move from the periphery towards central visual representation (**point H**, right) and then continue to reverse back into the periphery in an almost mirrored representation[4].



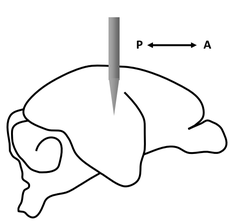
Electrode recording locations (left) and corresponding retinotopy (right)

Why have two seemingly redundant maps?

Do the cortical projections to these two maps differ?

Retrograde tracer injections

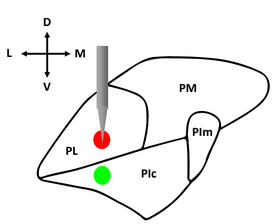
Adult galago
(*Otolemur garnettii*)



Pulvinar located and mapped electrophysiologically using an injectrode prior to injection of tracer.

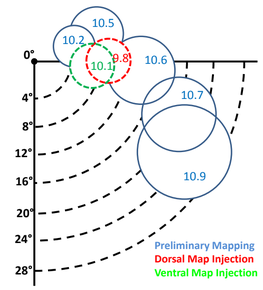
This was done in **3** subjects.

Injections guided by electrophysiology

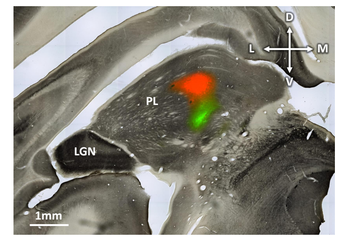


Fluorescently labeled **cholera toxin B (CTB)** was injected in both maps of left hemisphere before a 7 day period preceding **rabies** injections in the right hemisphere (total survival time: 14 days). All injections were 4µL of tracer.

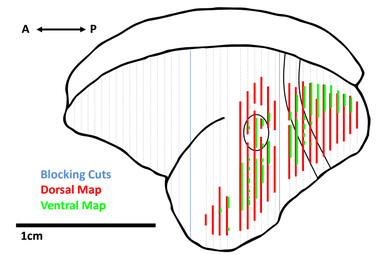
Neuron populations labeled by CTB are distinct



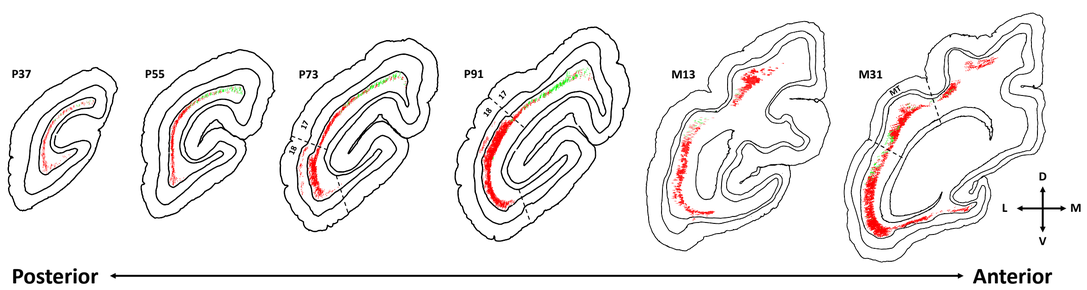
Retinotopic map with injection site locations



CTB injection sites superimposed on an adjacent CO stained section

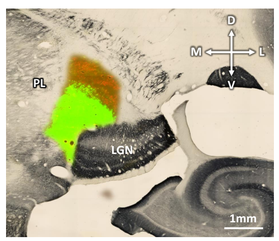


Labeled cells projected onto the surface of cortex at a 45° angle

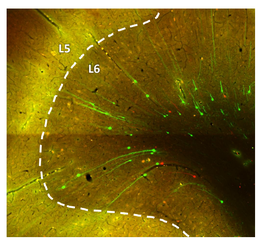


Both **striate** and **extrastriate** visual areas project to two pulvinar maps from non-overlapping neuron populations
Given that distinct neuron populations project to the pulvinar: **Do these cell populations differ in morphology?**

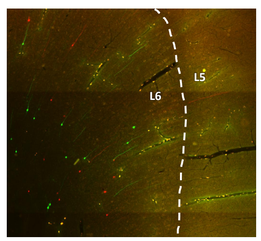
Rabies labeled cells exhibit similar morphology



Rabies injection sites superimposed on an adjacent CO stained section



Representative **area 17** pyramidal neurons



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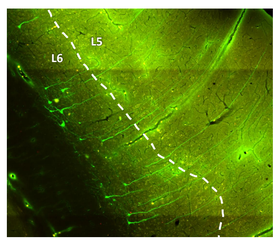
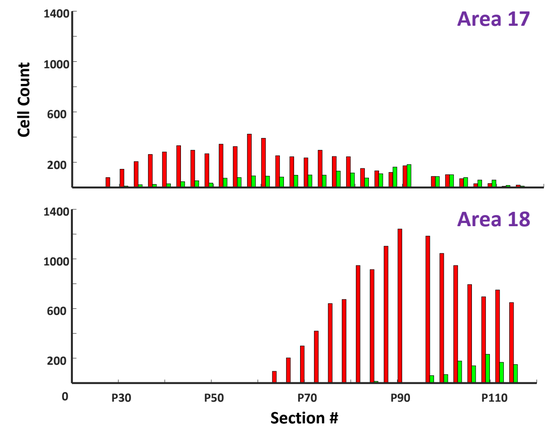


Representative **MT** pyramidal neurons

Labeled cell distributions

Neurons within **areas 17** and **18** are labeled by injections in either pulvinar map, but neurons in **area 17** were almost exclusively in **layer 6**, while neurons in **area 18** were in both **layers 5** and **6**.



Injections in the **dorsal map** label many more neurons in **area 18** than **area 17**. These results support the view that these two retinotopic maps have different functions, and that neurons in **area 18** are important in driving the **dorsal map**.

Summary

The two retinotopic maps of the galago pulvinar receive projections from **distinct populations** of layer 5 and 6 pyramidal cells in both striate and extrastriate cortices.

References & Acknowledgements

[1] Bridge H, Leopold DA, and Bourne JA. (2016). Adaptive pulvinar circuitry supports visual cognition. *Trends Cogn Sci*. 20:146–157.

[2] Jones, E. (2007). The Thalamus, 2nd ed. Cambridge University Press, UK:Cambridge

[3] Baldwin MKL, Balaram P, and Kaas JH. (2017). The evolution and functions of nuclei of the visual pulvinar in primates. *J Comp Neurol*. 525(15):3207-3226.

[4] Li K, Patel J, Purushothaman G, Marion RT, Casagrande VA. (2014). Retinotopic maps in the pulvinar of bush baby. *J Comp Neurol*. 521(15)

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