A Comparison of the Synaptic Input to Visual Areas V1 and V2 From Primate Pulvinar

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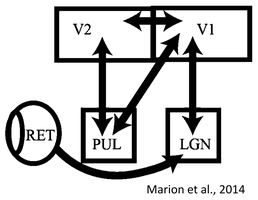
Introduction

How does information flow from the sensory periphery through the brain?

Thalamo-cortical projections have been proposed to either **drive** (provide the essential message) or **modulate** the main message to cortex[1]. Primary sensory nuclei, such as the lateral geniculate nucleus (LGN), are the best examples of drivers. It remains unclear whether higher order thalamic nuclei such as the pulvinar can drive cortex, modulate cortex or do both.

"Who drives and who modulates?"



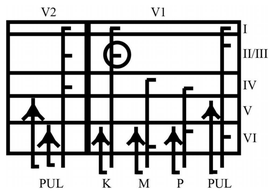
Marion et al., 2014

The visual pulvinar receives its drive from V1[2]. The lateral (PL) and inferior (PI) subdivisions of the visual pulvinar are reciprocally connected to V1 and V2[3,4].

Does information flow in a **hierarchical manner** from LGN to V1 and then V2? Or does the thalamus provide **driving** projections that are **modulated** by cortico-cortical connections?

Driving projections are argued to be distinct from those that are **modulatory** based on the layers of axonal termination[5,6].

However, driving connections also have been distinguished from modulatory projections based on other criteria such as bouton **size**, **position**, and **arrangement** as well as synaptic **protein content**[1,7,8].

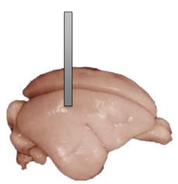


Marion et al., 2014

Do pulvino-cortical projections drive or modulate early visual areas?

Fluorescent and electron microscopy

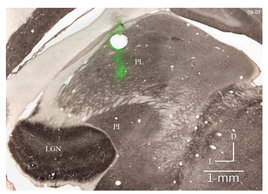
Adult bush baby
(*Otolemur garnettii*)



Lateral pulvinar (PL) located and mapped electrophysiologically using an injectrode prior to injection of tracer (right, green).

This was done in **4** subjects.

Tracer injections in PL

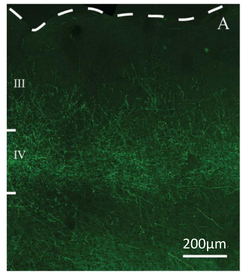


Biotinylated dextran amine (**BDA**) injected into PL (7 day survival period).

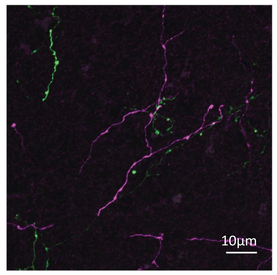
Axons visualized in V1 and V2 using streptavidin-HRP/tetramethylbenzidine/diaminobenzidine-cobalt stain.

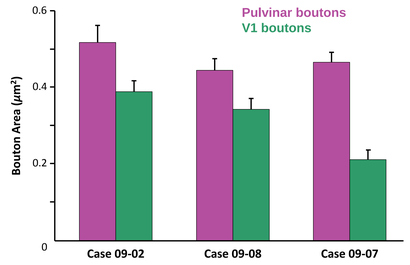
Ultrathin sections containing labeled axons immunolabeled for GABA with gold particles

Layer IV of V2 receives synapses with larger boutons from pulvinar



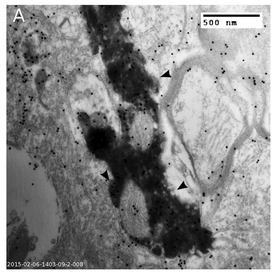
Pulvinar projections in V2

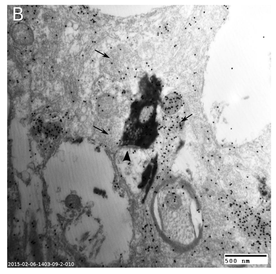




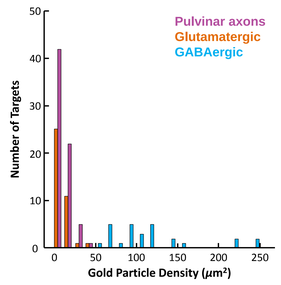
Pulvinar boutons are significantly **larger** than **V1** boutons that are found in V2.

V1 is strongly modulated by pulvino-cortical projections



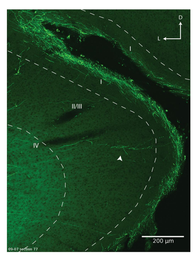


Two example labeled pulvinar boutons in V1 layer 1.
All of these synapses have **non-GABAergic** targets.

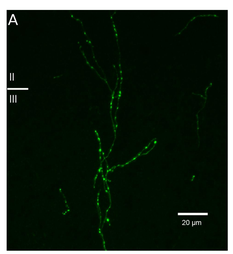


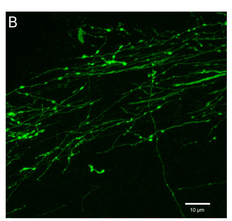
Pulvinar targets are **not** GABAergic

Pulvinar axons synapse with apical dendrites in layer 1 of V1

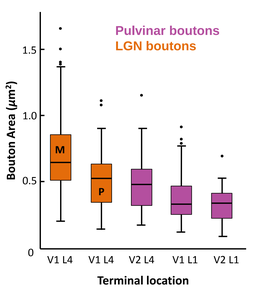


Pulvinar projections in V1

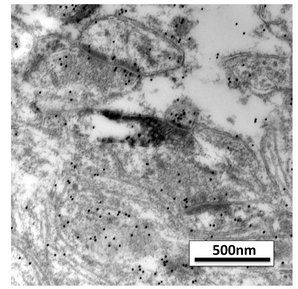


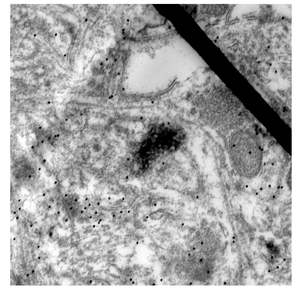


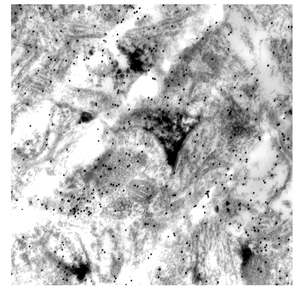
Axons in layer 1 (right) run within the upper single sub layer. Those in layer 2/3 (left) arborize radially or obliquely to the layer border.

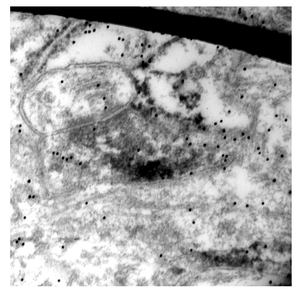


Pulvinar projections could drive V2









Four example labeled pulvinar boutons in V2 layer 4.
Most of these synapses have **non-GABAergic** targets.

Summary

We propose that the pulvinar's projections to V2 act as **drivers** while those to V1 act as **modulators** of cortical activity.

References & Acknowledgements

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