Does V3 Represent a Unique Target of the Koniocellular Pathway?

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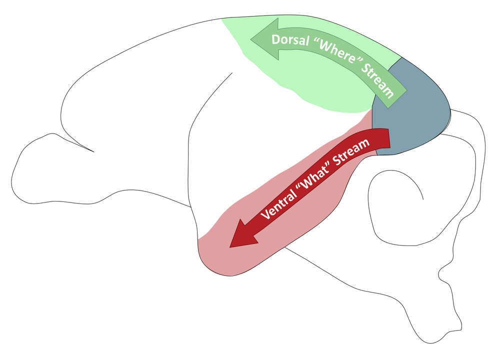
Introduction

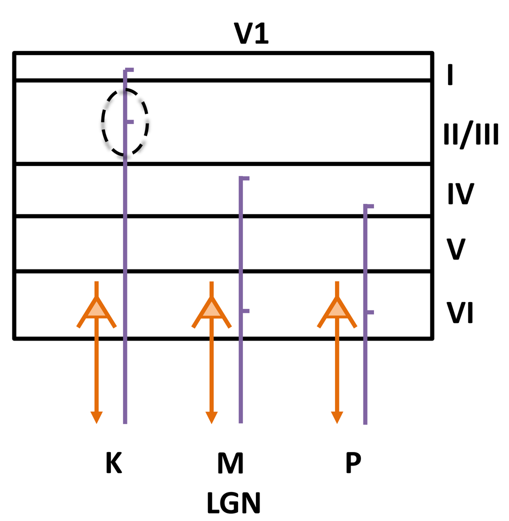
V3's role within the two-stream model is contentious



The primate visual system exhibits a well studied division of labor in which dorsal extrastriate areas are though to contribute to visuospatial processing while those regions in the ventral "stream" are concerned with the form and color of objects.[1] The functionality of area V3 remains difficult to classify, however, as it has prominent connections with areas in both of these divisions.[2,3]

Division of labor begins at the earliest stages of the visual system

Functional segregation occurs, to some extent, at the beginning of the brain's visual hierarchy. The lateral geniculate nucleus (LGN) of the thalamus contains three major functionally distinct classes of cells: magnocellular (M), parvocellular (P), and koniocellular (K).[4] These cell types have distinct projection patterns in primary visual cortex (V1) that contribute to the aforementioned parallel visual "streams".[5]

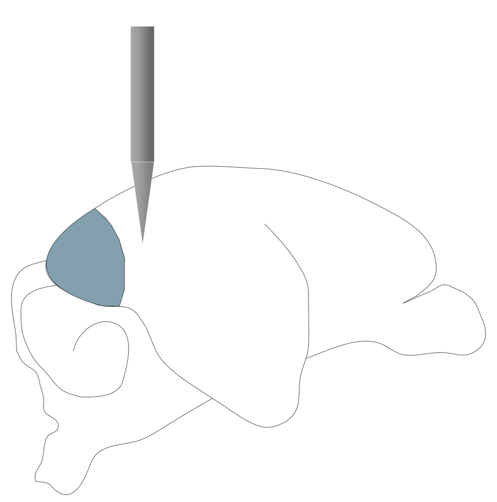


Rather than infer the functional role of V3 from extrastriate connections, we used retrograde tracers to examine the distribution V1 neurons that project to V3. These cells were considered in the context of LGN projections to approach the question:

What can V1's projections tell us about V3's functionality?

Retrograde tracer injections

Adult bush baby
(*Otolemur garnettii*)



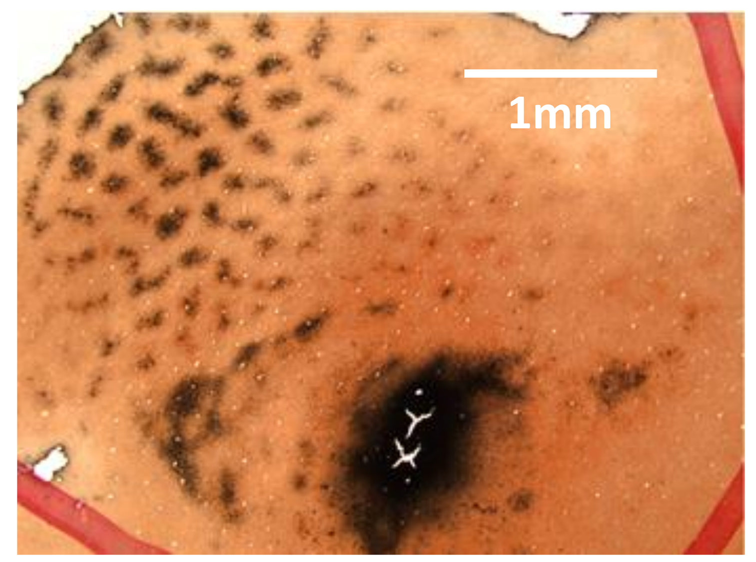
V3 located stereotaxically based on previous optical imaging studies.[6]

Tracer injections in V3

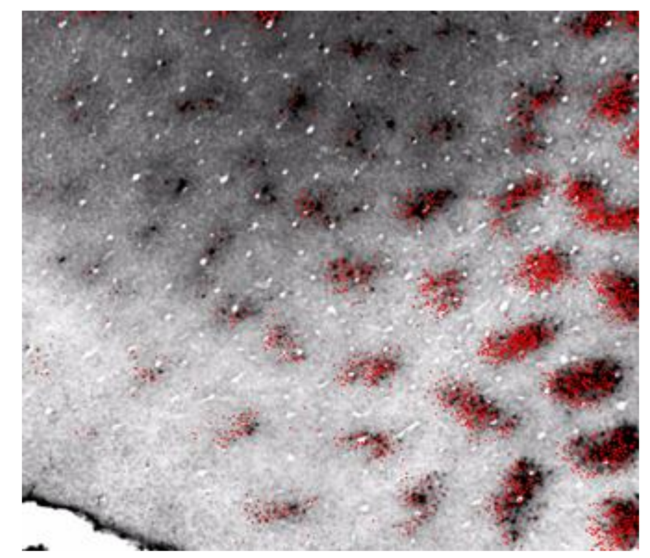
Four adult bush babies were injected in V3 with the gold-labeled beta subunit of cholera toxin (CTB) to retrogradely label V1. One case was injected with DiI for analysis along the depth of cortex. Injections were made 500µm apart at a depth of 100µm.

Perfusion occurred following a 7 day survival period after which tissue was sectioned both after cortical flattening and along the coronal plane.

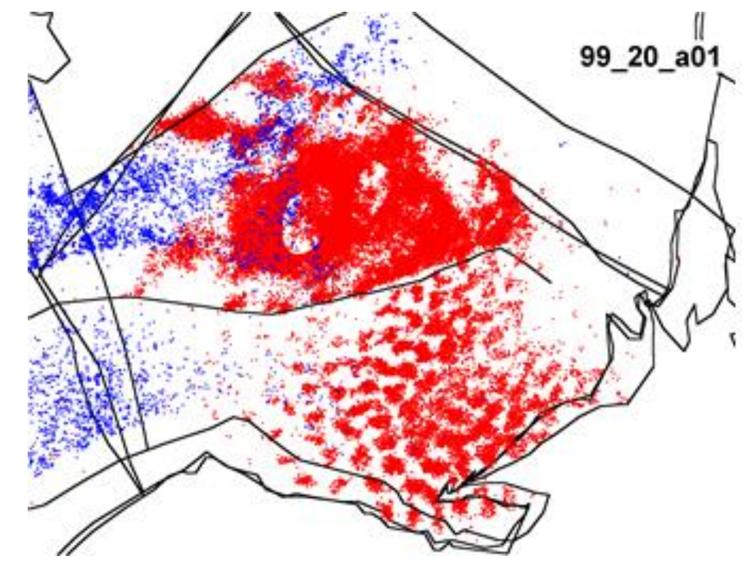
V1 cells that project to V3 are distributed within the CO blob columns



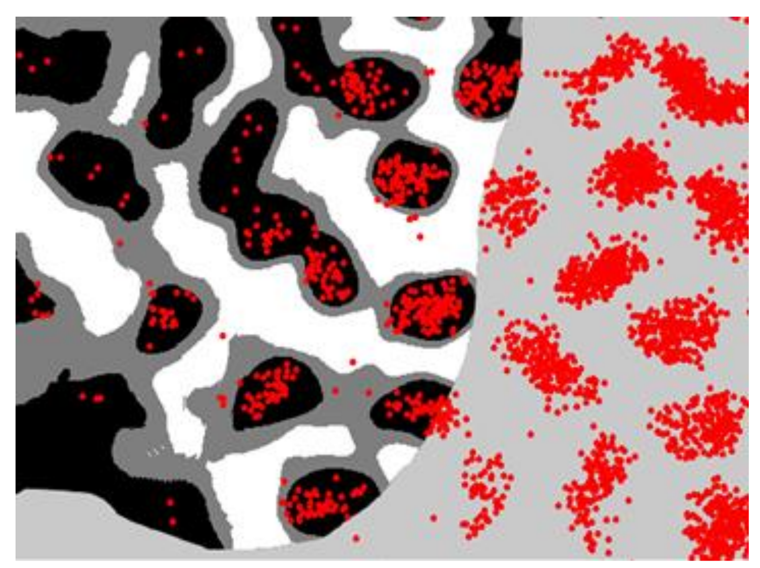
Intensified label in **V1** with **V3** injection sites (arrows)



Representative CO stain with labeled cells shown in red



Representative aligned composite with labeled cells indicated in red

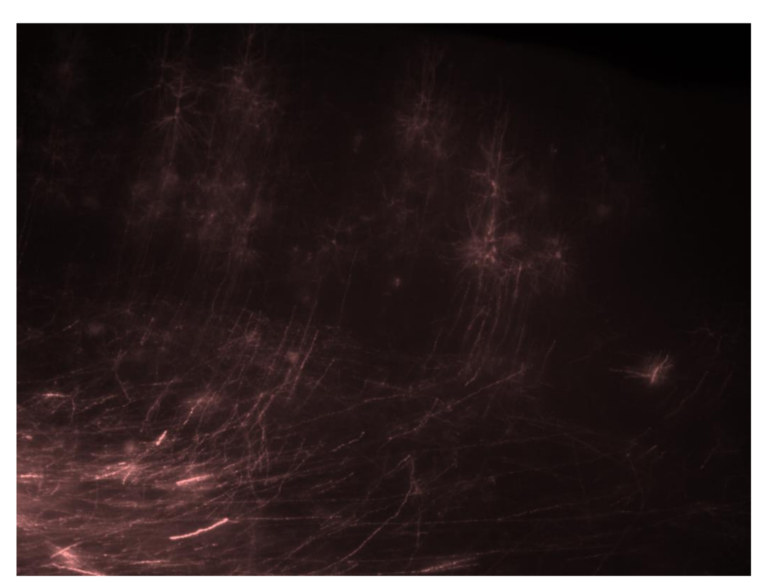


Thresholded CO stain with blob, interblob, and border regions shown in relation to labeled cells

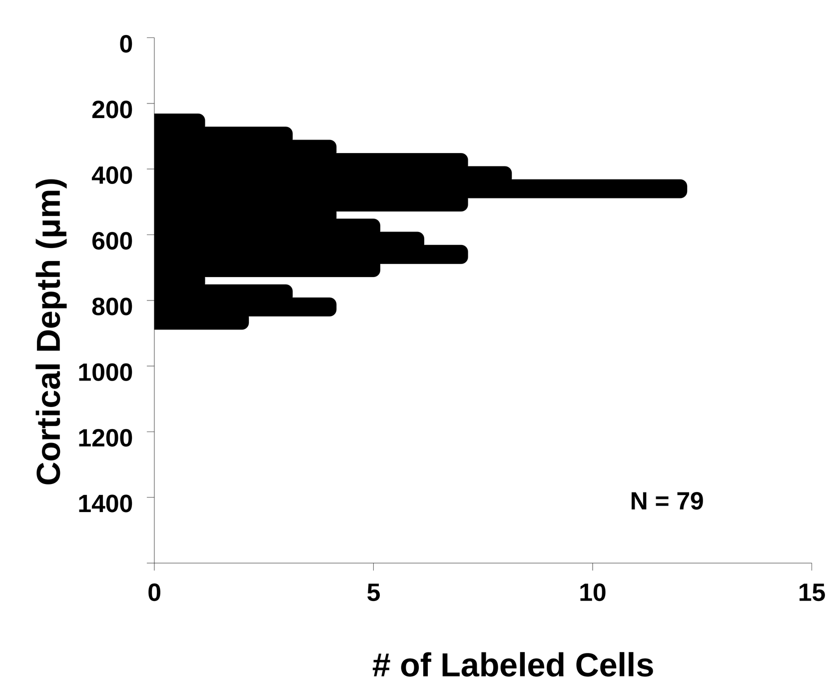
Case	# of Cells in Blobs	# of Cells in Interblobs	Cell Density in Blobs (cells/mm²)	Cell Density in Interblobs (cells/mm²)	χ^2
1	585	199	445.46	53.87	**2.45e-208**
2	2030	695	969.03	283.93	**4.28e-194**
3	690	13	162.94	3.2551	**1.41e-231**

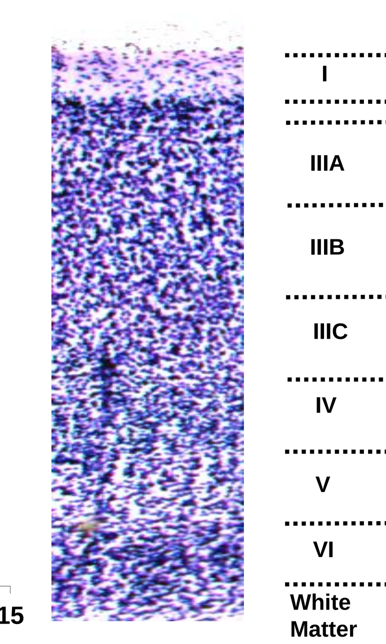
Labeled cells are unevenly distributed in V1 and fall within **CO blob columns** ($p<0.0001$)

Striate layer 3 neurons afferently project to V3



DiI injections in V3 heavily label **layer 3** of V1

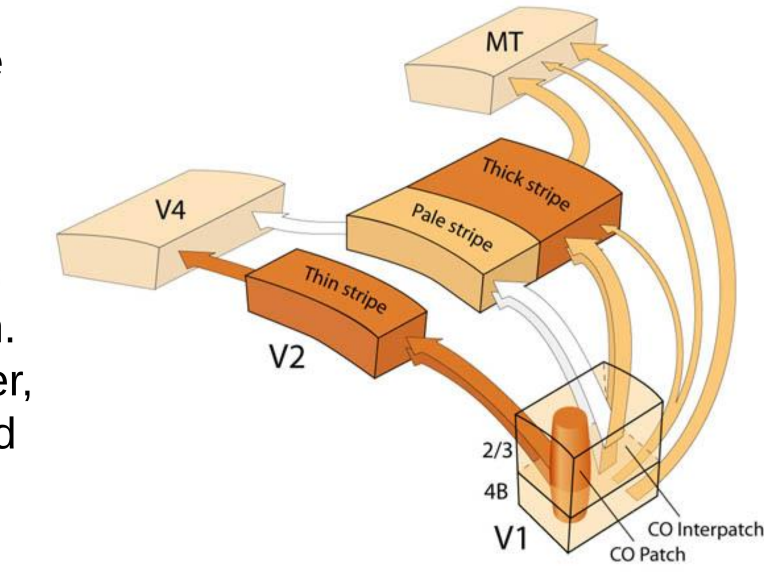




V1

Speculation

The two-stream model of the visual system has long held the division of a "where" and "what" pathway by which information processing tasks are functionally broken down. Extrastriate area V3, however, has not been easily classified into either of these streams.



V3 is known to receive projections from both streams and has been historically difficult to functionally classify. We show that this area receives projections from the CO blobs located in V1's layer 3.

Unlike the magnocellular and parvocellular layers of the LGN, the koniocellular layers project directly to V1's CO blobs.

We suggest the possibility of the K-V1-V3 pathway, however, further research is required to elucidate the functional ramifications of such a system.

Summary

V1's **CO blobs** project directly to visual area **V3**. More specifically, these cells fall within a cortical layer that receives it's prominent input from the LGN's K cells which implicates **V3** as a possible target of the **K pathway**.

References & Acknowledgements

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