# Color blobs in visual areas V1 and V2 of the Common Marmoset. [1]

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#### Introduction:

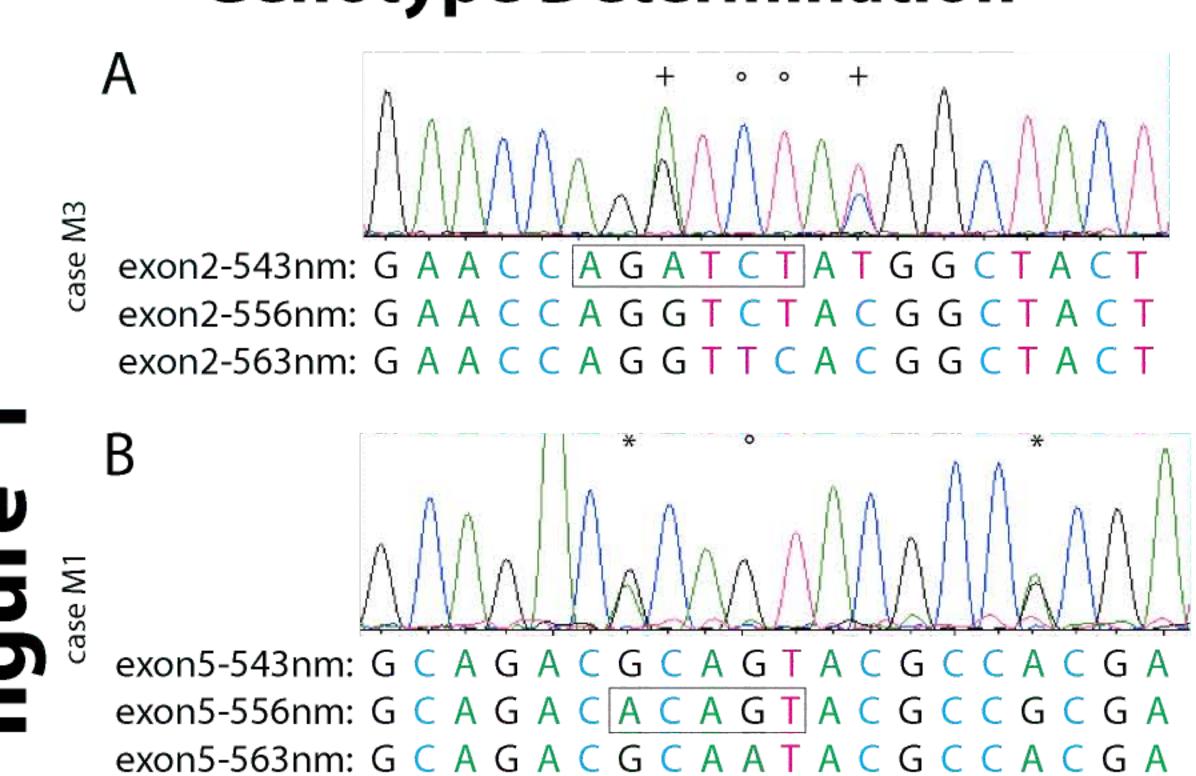
Color vision is reserved to only few mammals, such as Old World monkeys and humans. Most Old World monkeys are trichromats. Among them, macaques were shown to exhibit functional domains of color-selectivity, in areas V1 and V2 of the visual cortex [2,3,4]. Such color domains  $\blacksquare$ have not yet been shown in New World monkeys. In marmosets a sex-linked dichotomy results in dichromatic and trichromatic genotypes, rendering most male marmosets color-blind [5]. Here we used trichromatic female marmosets to examine the intrinsic signal response in V1 and V2 to chromatic and achromatic stimuli, using intrinsic optical imaging (IOI).

## **Methods:**

In order to activate the visual subsystems (magnocellular {(L+M)-cones}, parvocellular {(L-M)-cone}, koniocellular {S-(L+M)cones} pathways) individually, we used spatially homogeneous isoluminant color opponent (red/green, blue/yellow) and hue versus achromatic flicker (red/gray, green/gray, blue/gray, yellow/gray), as well achromatic luminance flicker (2) A recently de-(black/white) (figure 2). scribed multimodal vessel mapping approach [6] allowed for an accurate alignment of the functional and anatomical datasets (figure 5).

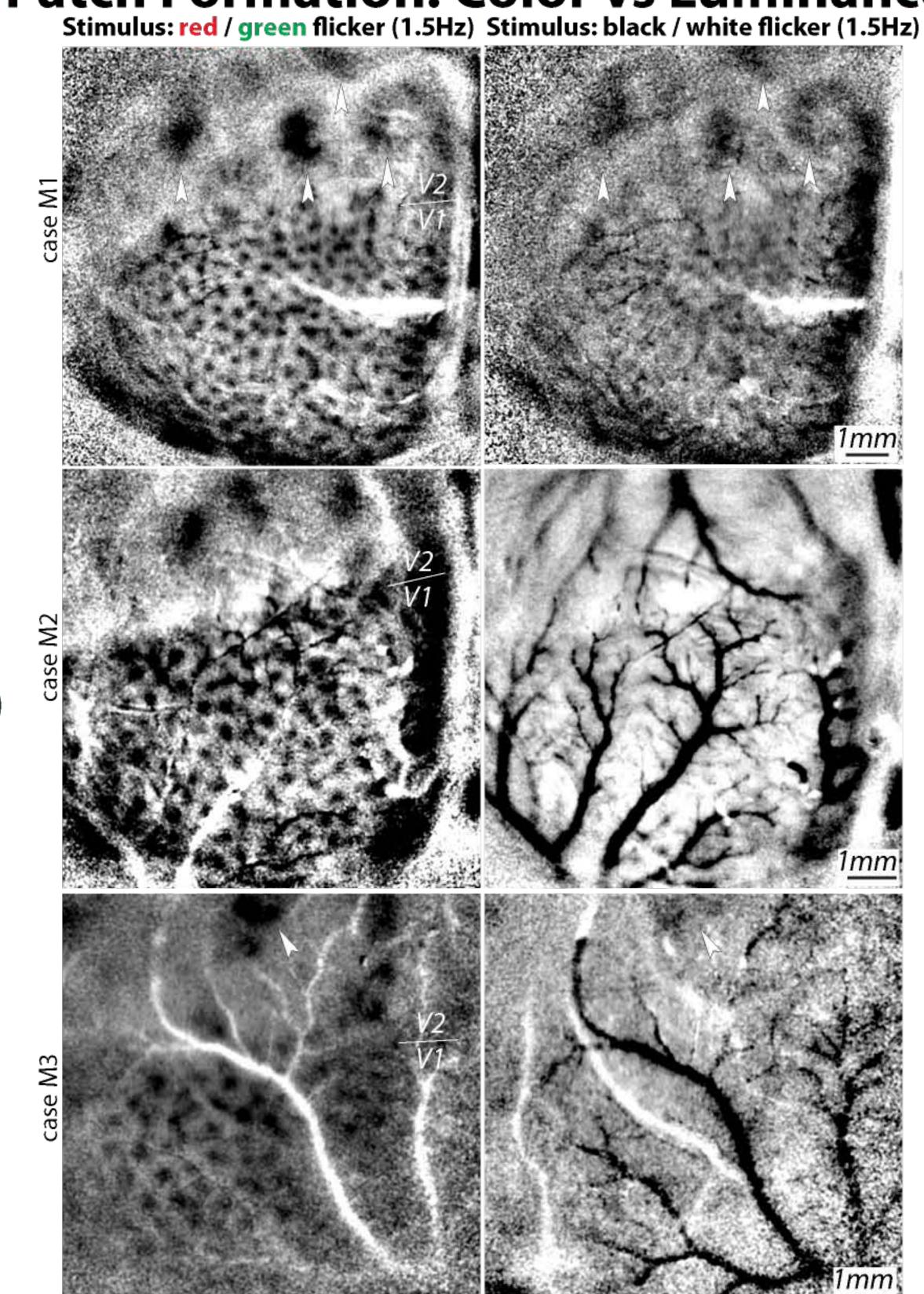
A genetic analysis was performed to determine the color visions status (dichromat/trichromat) of the monkeys. Samples were taken from the blood less liver to avoid false positive results due to chimerism [7].

# **Genotype Determination**

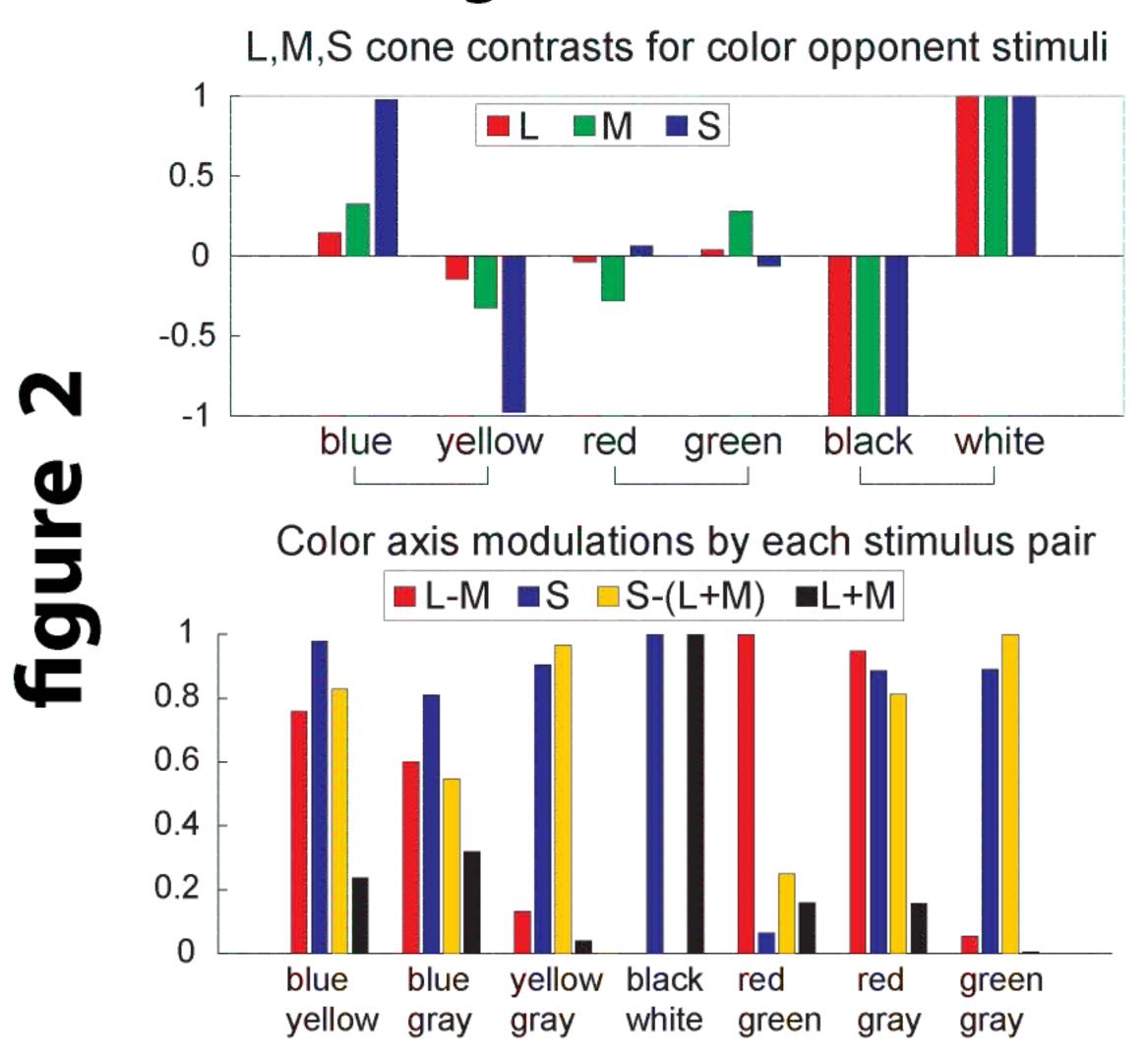


A shows the sequences of the three alleles of the opsin gene around the 543nm specific Bglll site (boxed) in exon 2 described by [5]. Sense strand. M1, M2 were identical. B shows the sequences of the three alleles around the 556nm specific HpyCH4III site (boxed) in exon 5 described by [5]. Anti sense strand. M2, M3 were identical. (+) confirms presence of an allele for 543 nm; (\*) confirms presence of an allele for 563nm.

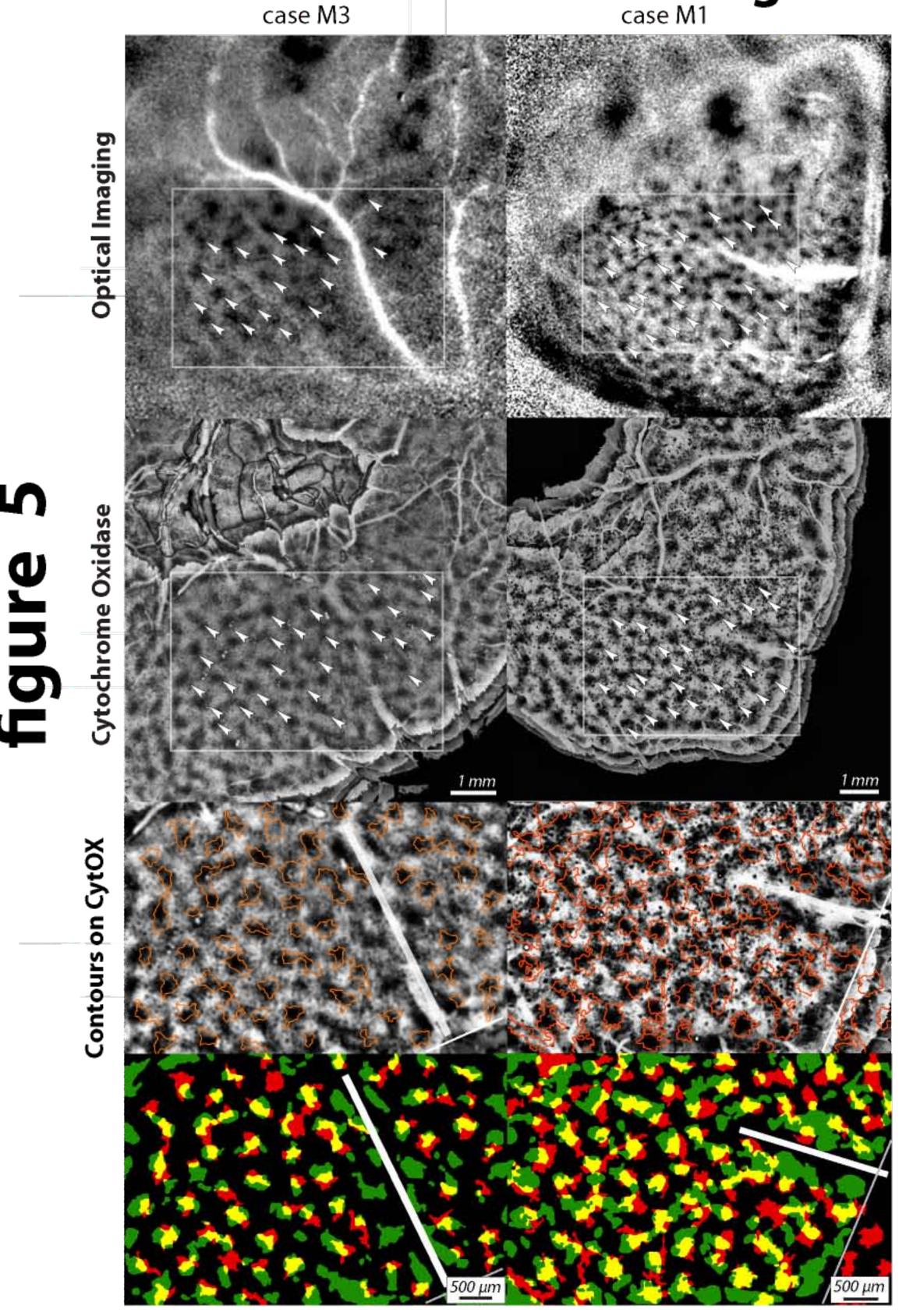
# Patch Formation: Color vs Luminance



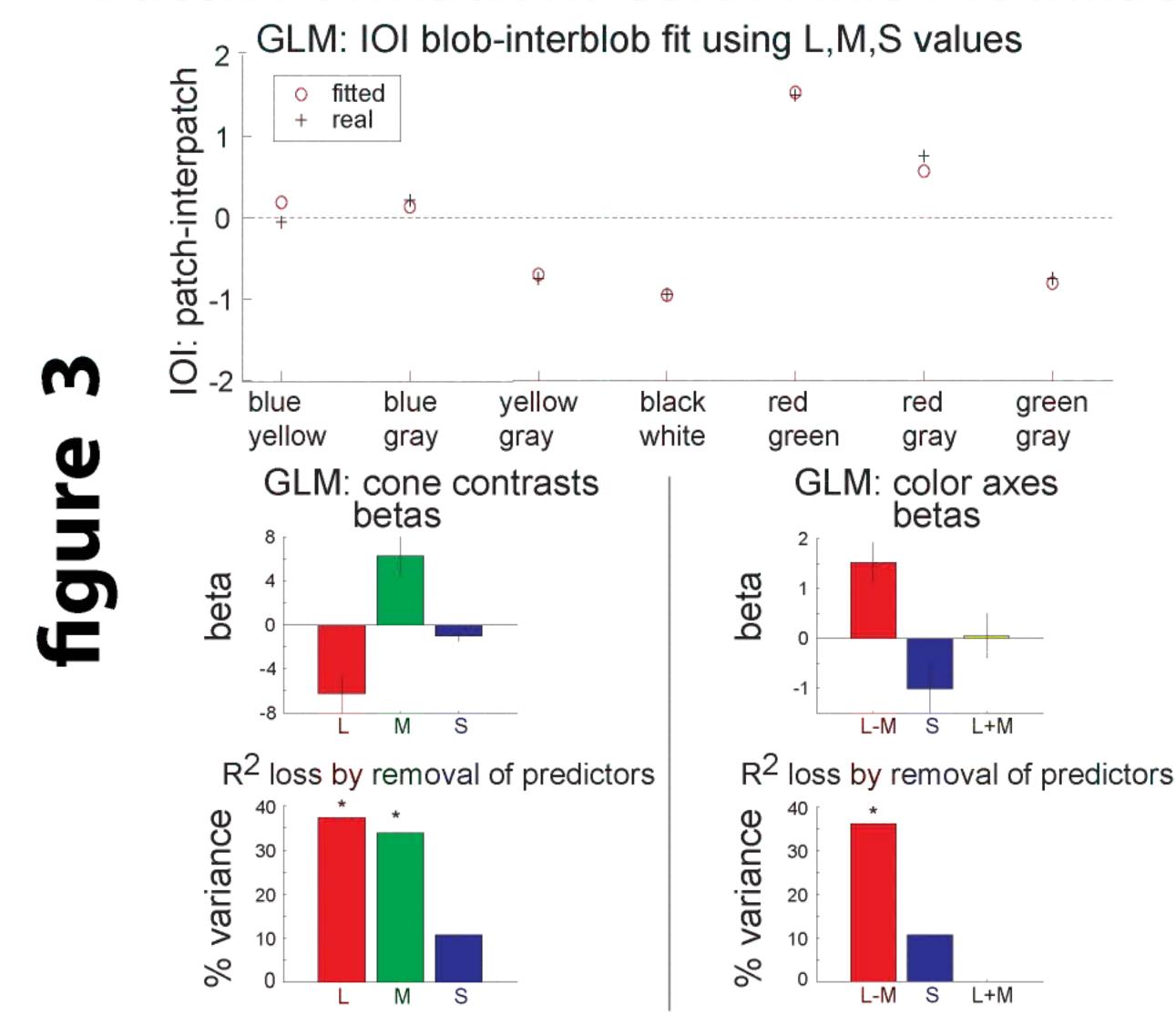
## Stimulus Design and Cone Activation



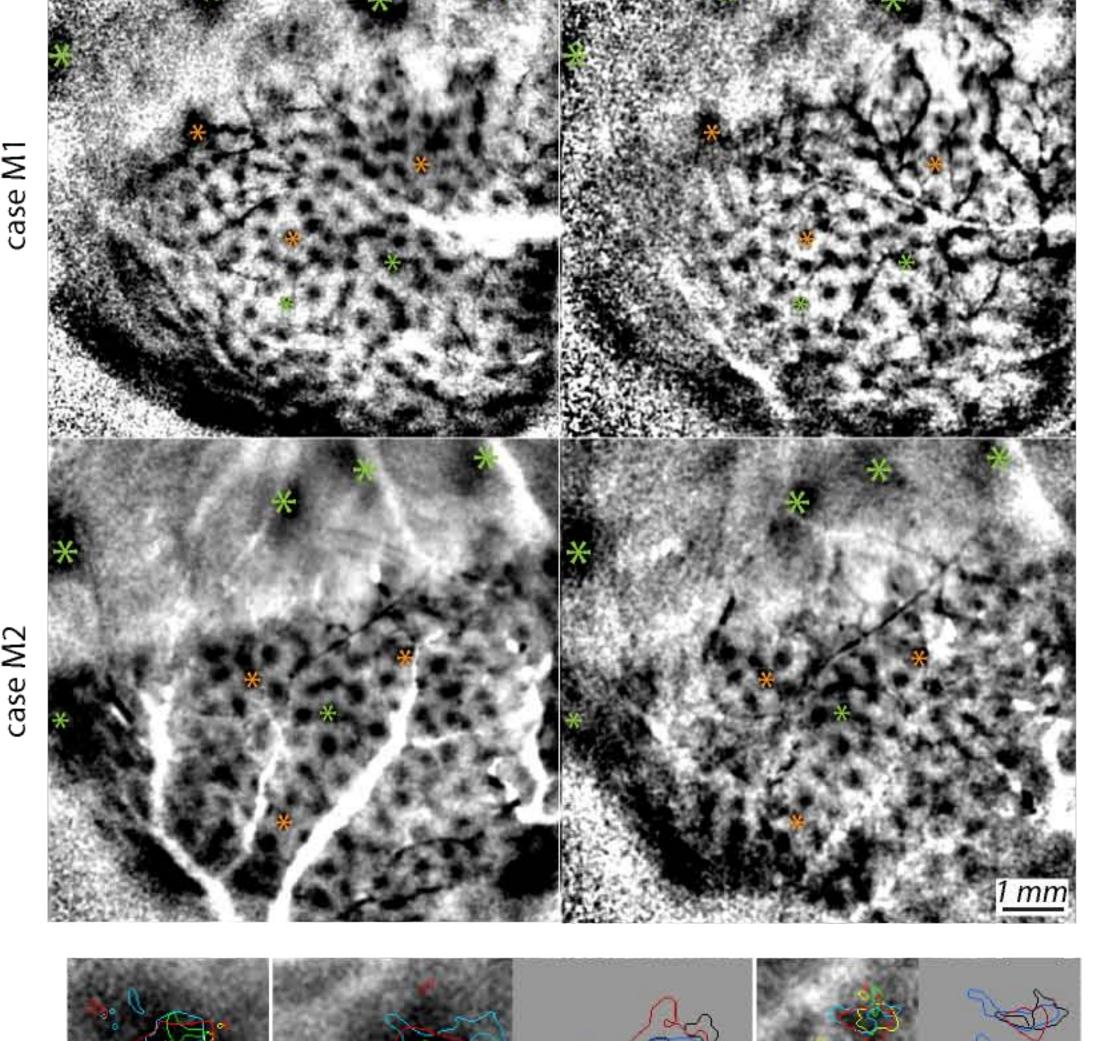
# Functional-Anatomical Alignment



### Patch Formation: Color Axis Modulation



# Ocular Dominance / Maps in V2



Case M3

Contours of functional domains on CytOx thin stripes in V2

## **Results:**

We find clearly segregated color domains, similar to those seen in macaques.

- Red/green and red/gray flicker were found to be the appropriate stimulus for revealing color domains in single condition maps (figure 4).
- Blue/gray and blue/yellow flicker stimuli resulted in faint patch-patterns.
- Genetic analysis confirmed trichromacy.
- Patch formation is driven by (L-M)-cone contrast modulation with only little influence of the S and no influence of the (L+M)-(luminance) axis (figure 3).
- Color domains were tightly colocalized with cytochrome oxidase (CytOx) blobs in V1 and with thin stripes in V2 (figure 5).
- Centre-to-centre distances : CytOx blobs =  $416-417\mu m$  color patches =  $404-448\mu m$  dislocation error =  $\sim 83-85\mu m$
- No difference between patch intervals in binocular and monocular conditions (figure 6).
- We find no spatial organization representation of hues in color domains of V2 (figure 7).

#### **Conclusions:**

Our findings are in accord with 2-Deoxy-D-glucose studies performed in V1 of macaques [8] and studies on color representation in V2 [9]. Our results suggest a similar organization of early cortical color processing in trichromats of both, Old World and New World monkeys. In contrast to macaques monkeys blobs in trichromatic marmosets seem to be innervated bionocularly. Also, marmosets seem to lack hue maps in thin stripes of V2.



[1] Valverde Salzmann MF, Bartels A, Logothetis NK, Schüz A (2012) Color Blobs in Cortical Areas V1 and V2 of the New World Monkey Callithrix jacchus, Revealed by Non-Differential Optical Imaging. The Journal of Neuroscience 32:7881-7894.

Overlap of functional domains and CytOx rich zones

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