Color Variability Analysis in Fundus Photography

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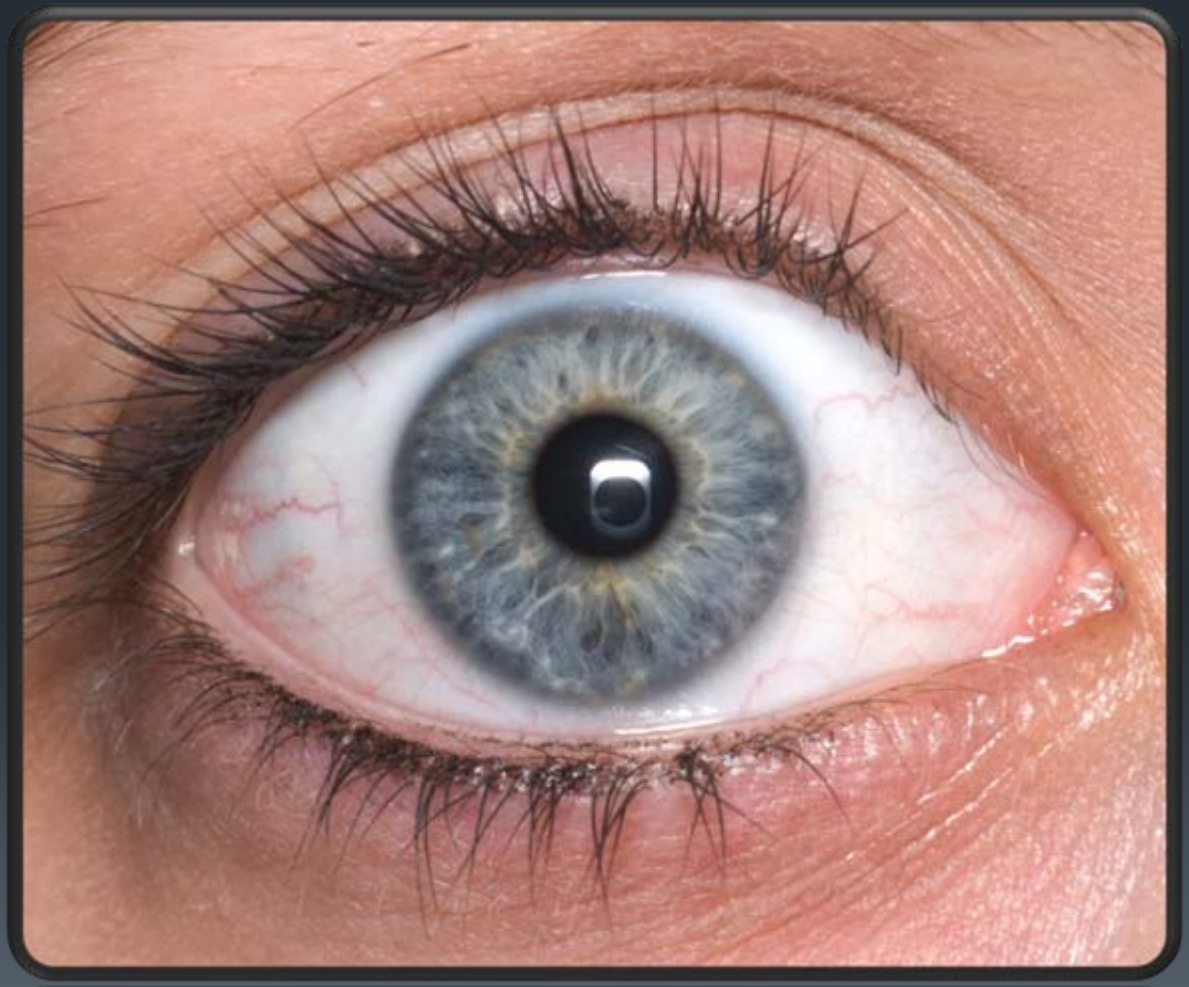
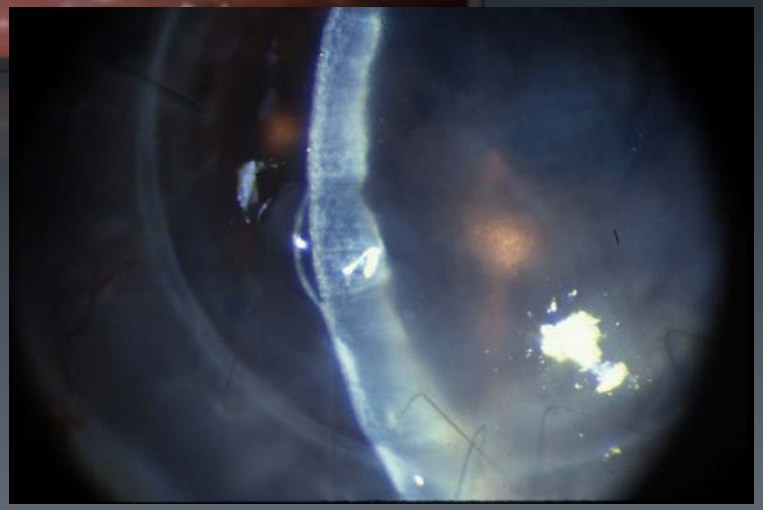
Anterior Segment

External (pre/post op)



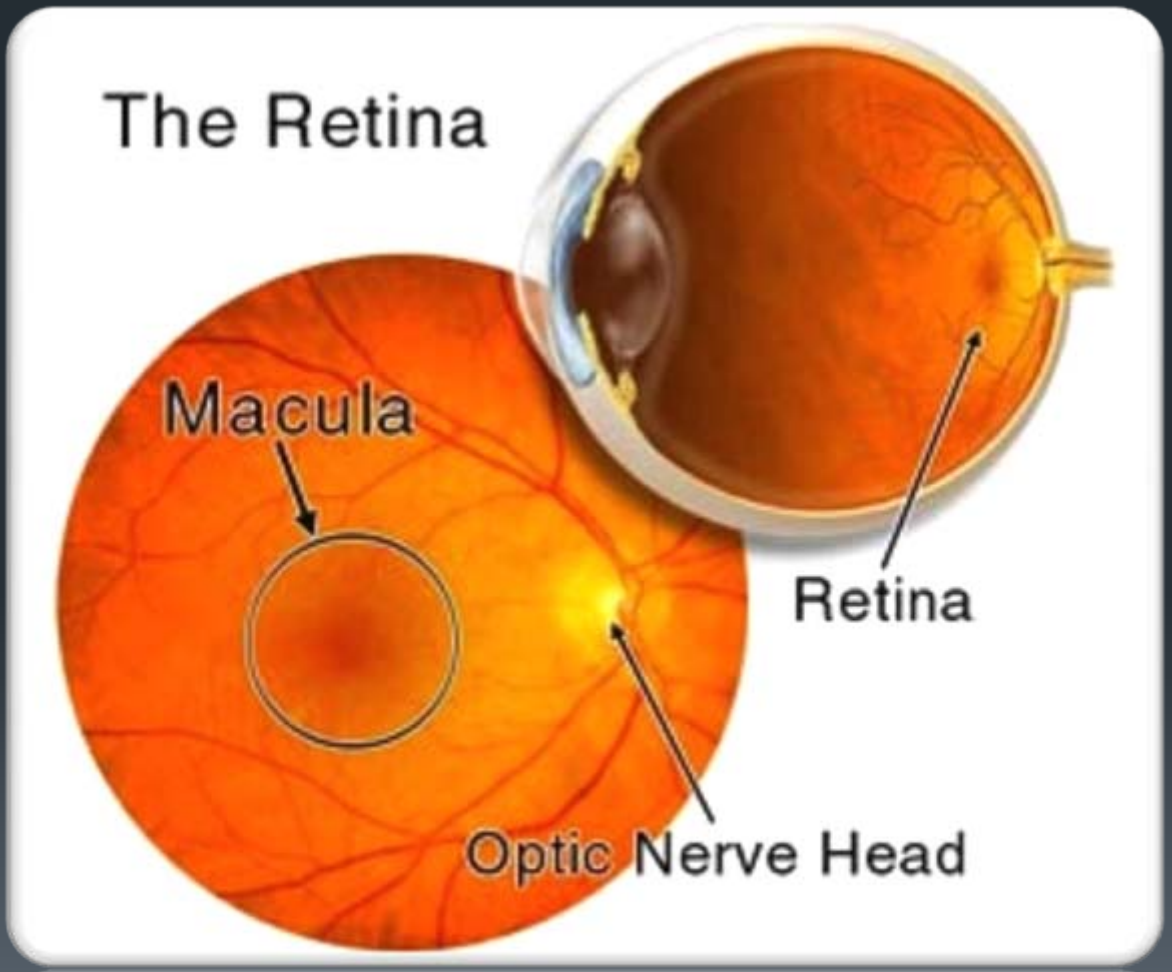
Anterior Segment

Slit Lamp Biomicrography



Posterior Segment Imaging

Retinal Fundus Photography



Retinal Variation Across Populations

Determined by ethnicity, pigmentation, disease process

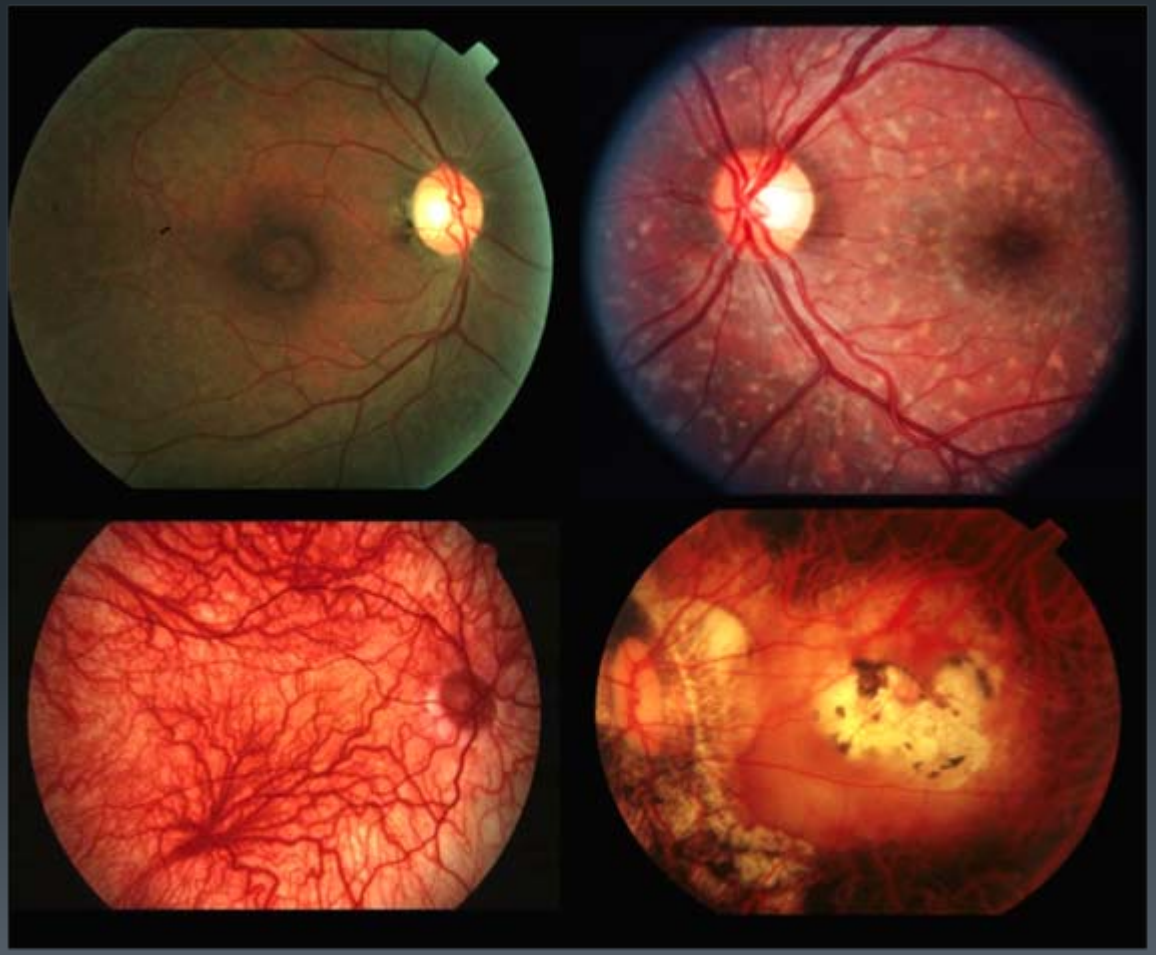
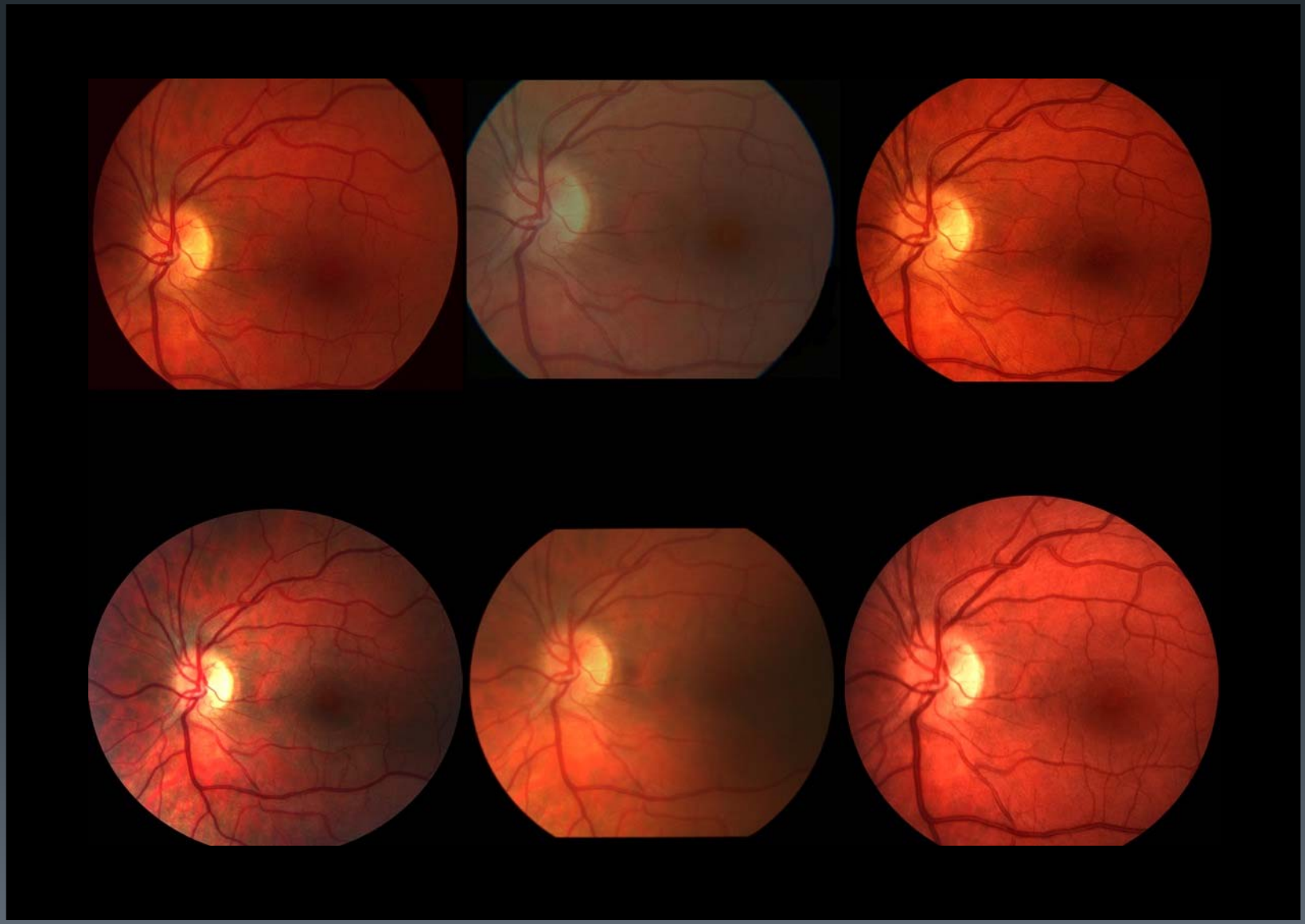


Image Variables

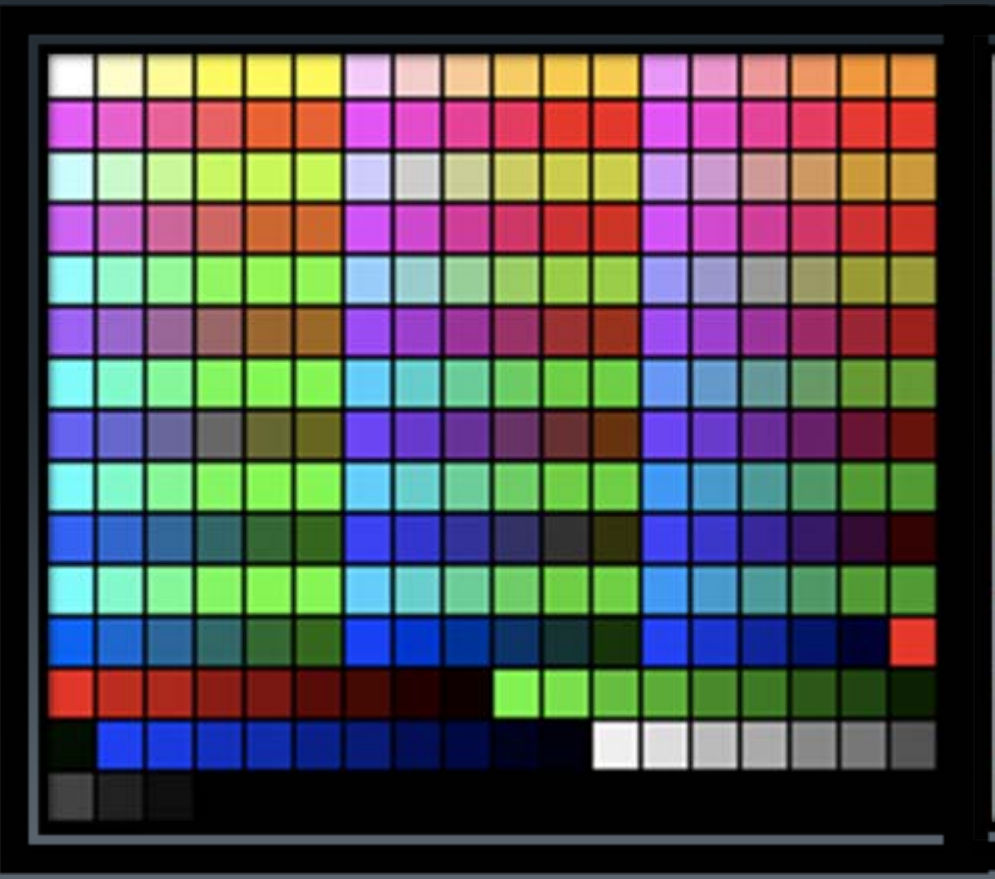


Why So Different?

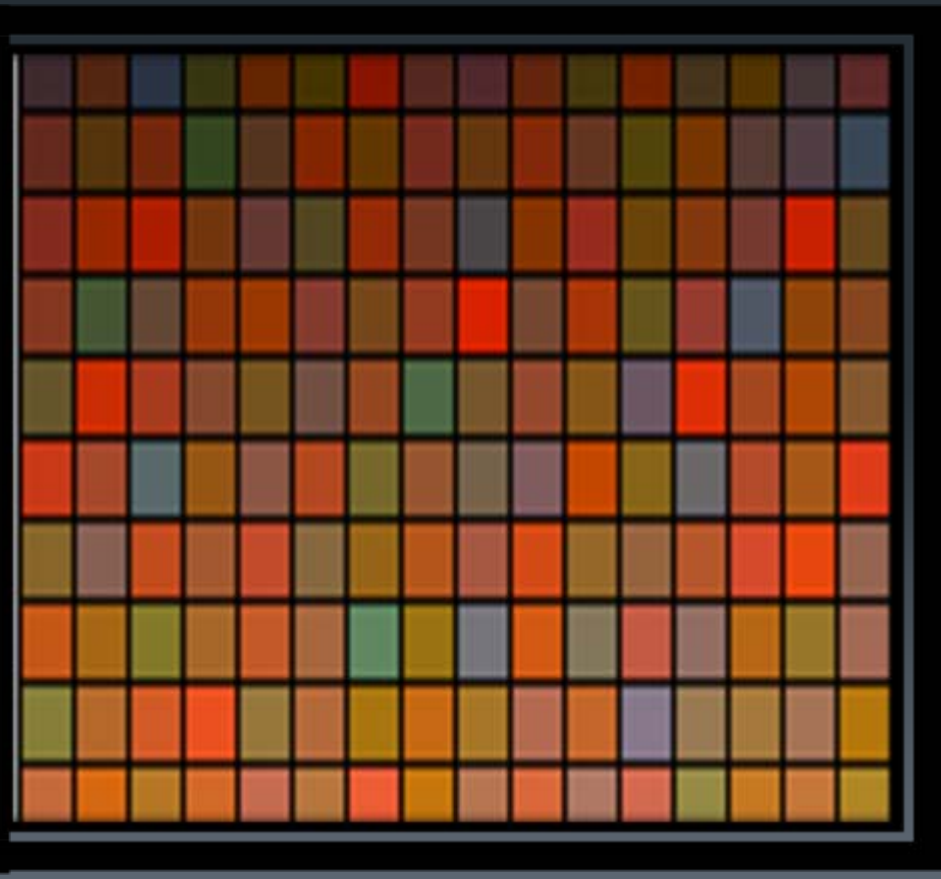
- Every fundus camera manufacturer has a different idea of what “correct color” looks like in fundus photography
  - Varies widely within the same manufacturer
- The eye is the other half of the optical system

CCD Color Reproduction

Standard colors

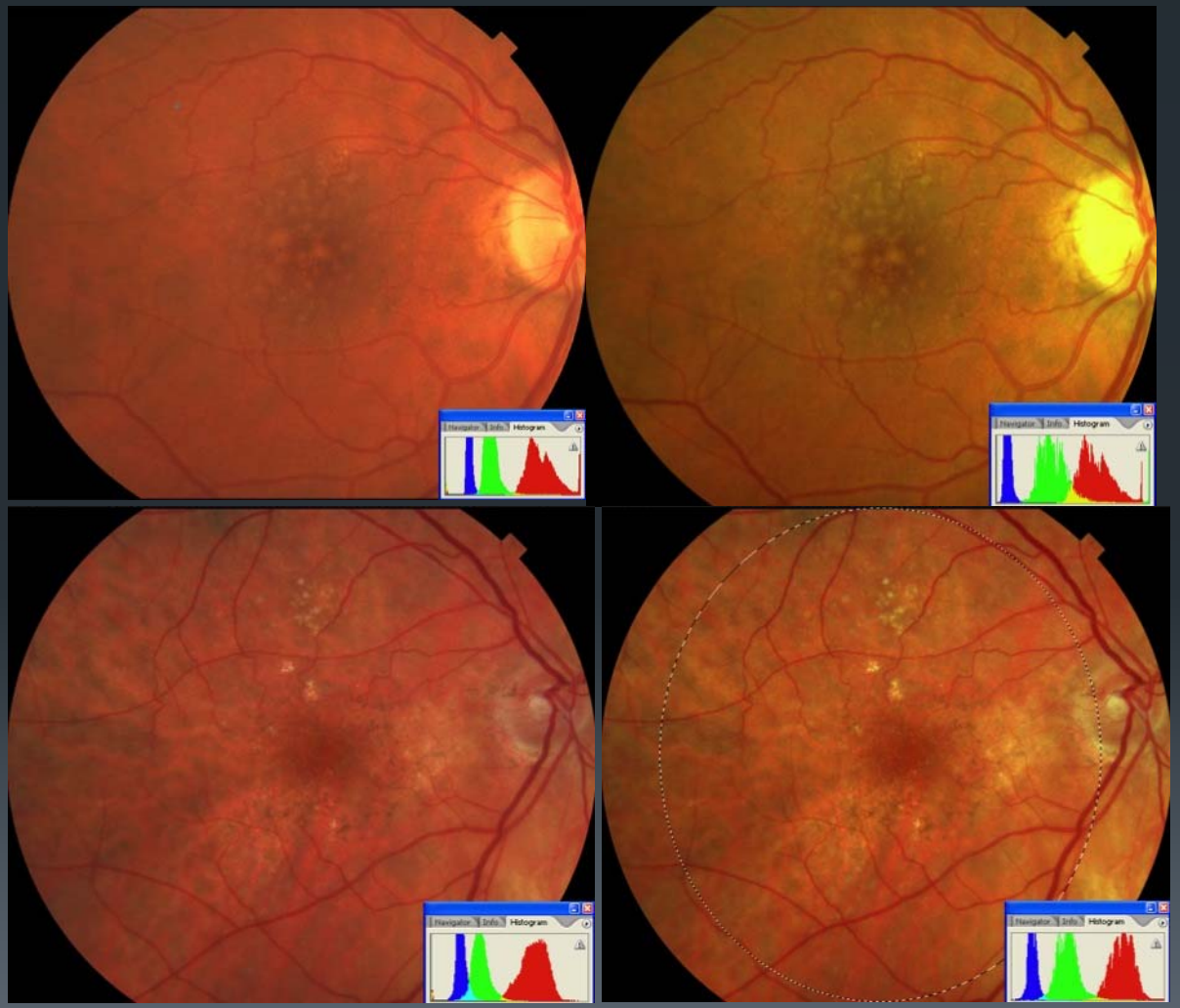


Retinal colors



Why So Important?

- Medical record
- Color influences diagnosis
  - Disc pallor
  - Pigmentation changes
  - Tele-ophthalmology applications
  - Clinical trials



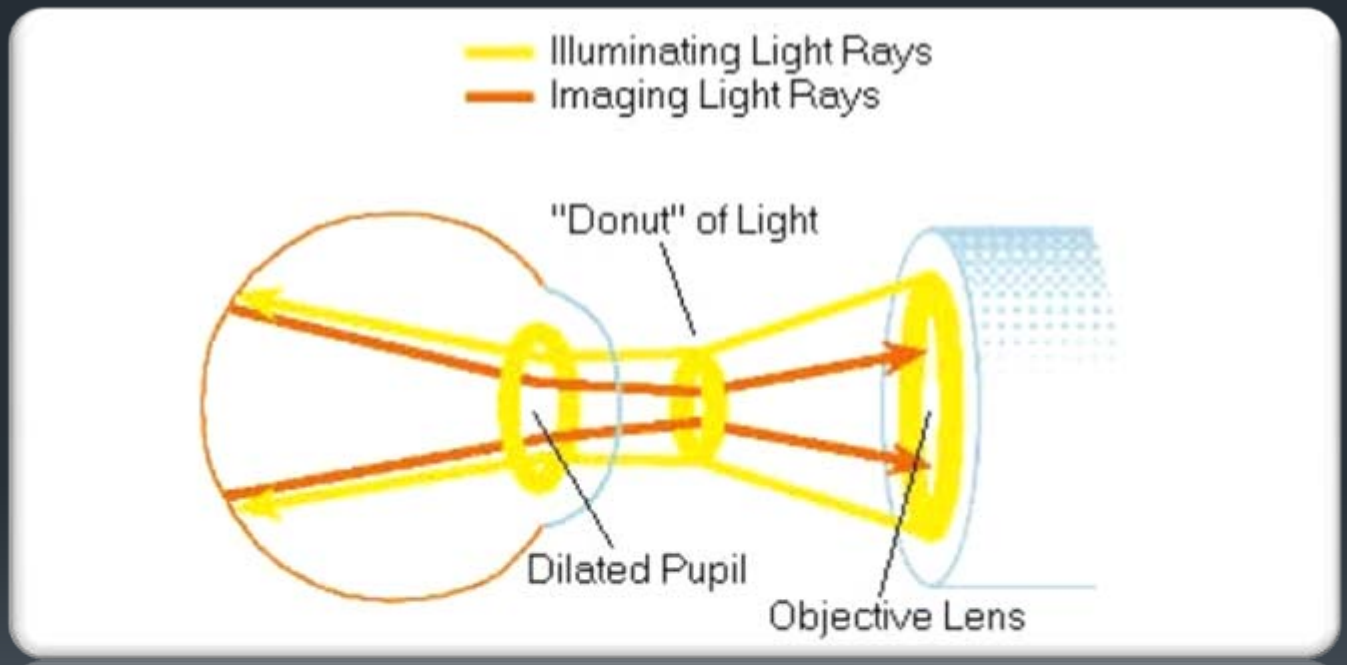
Images courtesy of Larry Hubbard and Richard Danis, MD, Fundus Photograph Reading Center, University of Wisconsin, Madison

Imaging Procedure

- Iris dilated pharmaceutically
- Once dilated, patient aligned in fundus camera headrest
- Photographer adjusts working distance for optimal illumination, focus
- Photograph taken using flash

Image courtesy of National Eye Institute: http://www.stylewiz.com/mnr/nei/photo-gallery.php

Eye as other half of optical system



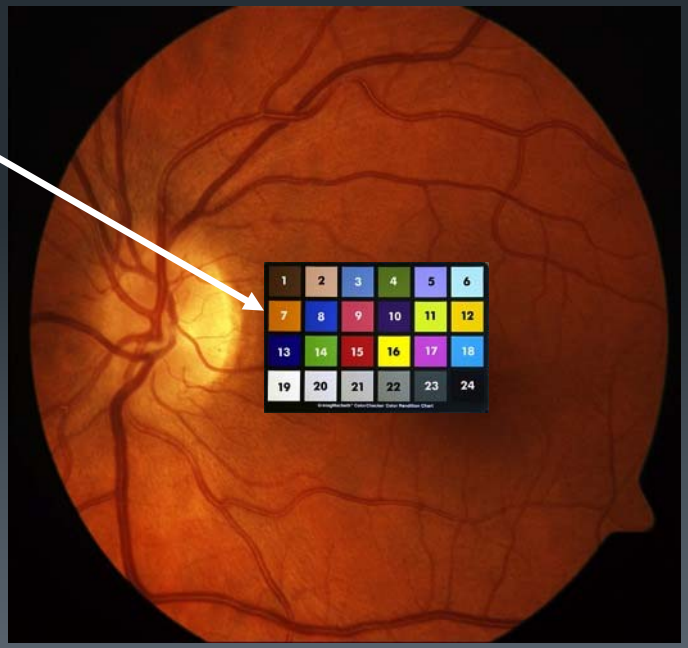
Ophthalmic Photography: Retinal Photography, Angiography, and Electronic Imaging, 2nd Edition Patrick J. Saine and Marshall

Questions

- How different are the cameras in terms of color?
  - What is the best way to determine color differences?
- Can fundus cameras be profiled?

Another Issue…

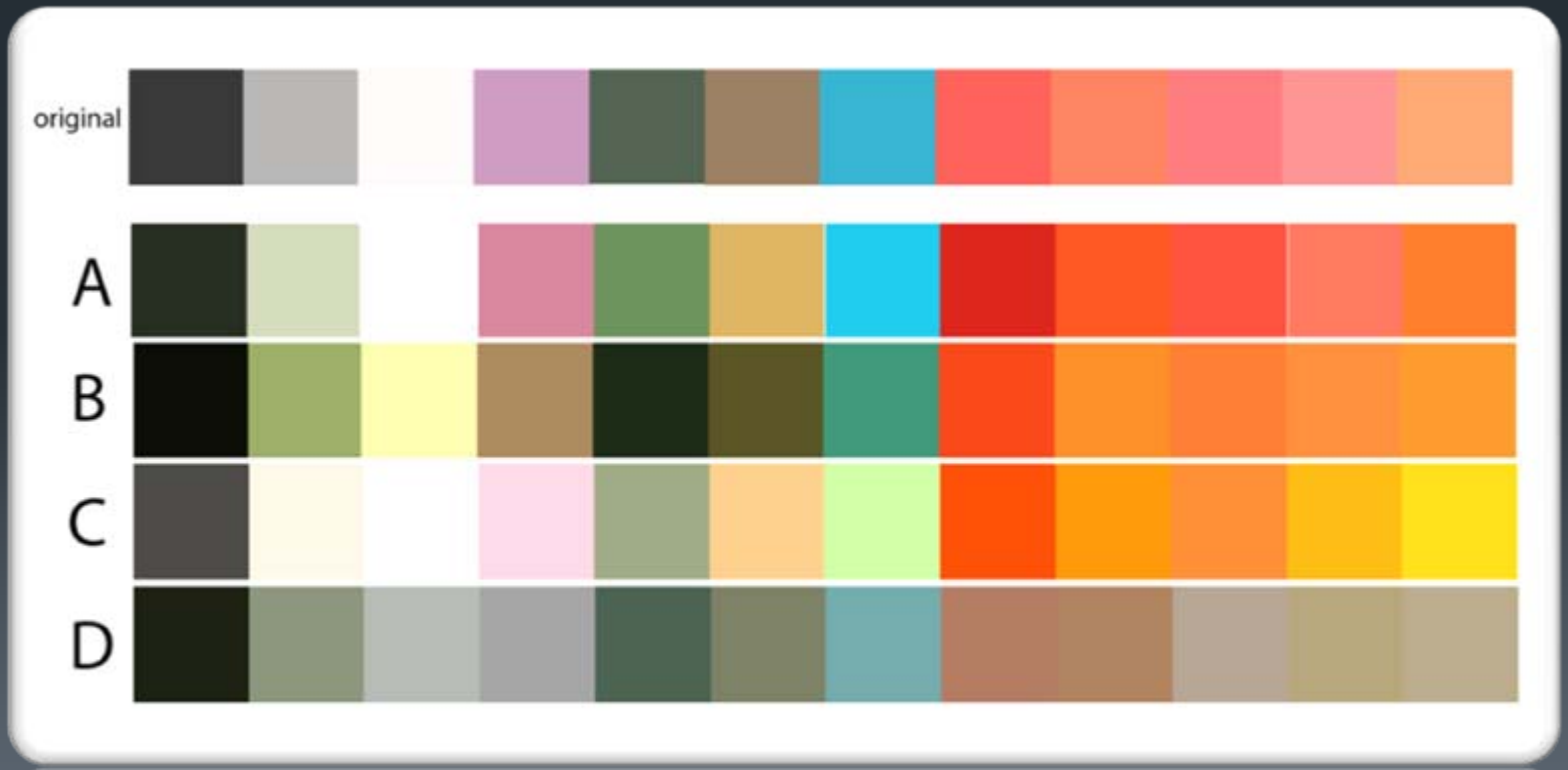
- How do I practically profile my input? (fundus camera)



Cameras

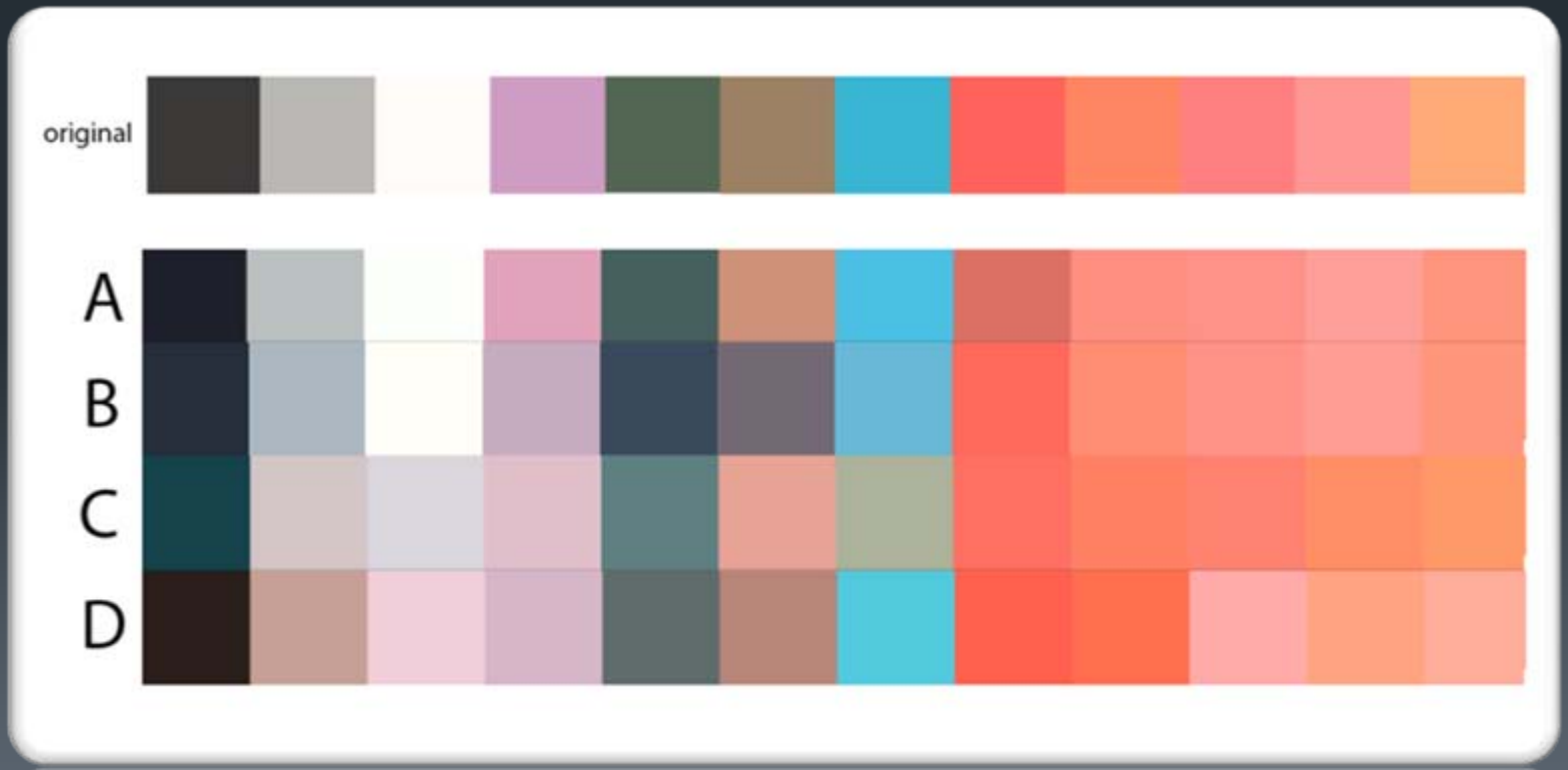
Procedure

- Started with a known color targets, photographed each color patch inside a model eye with four different cameras



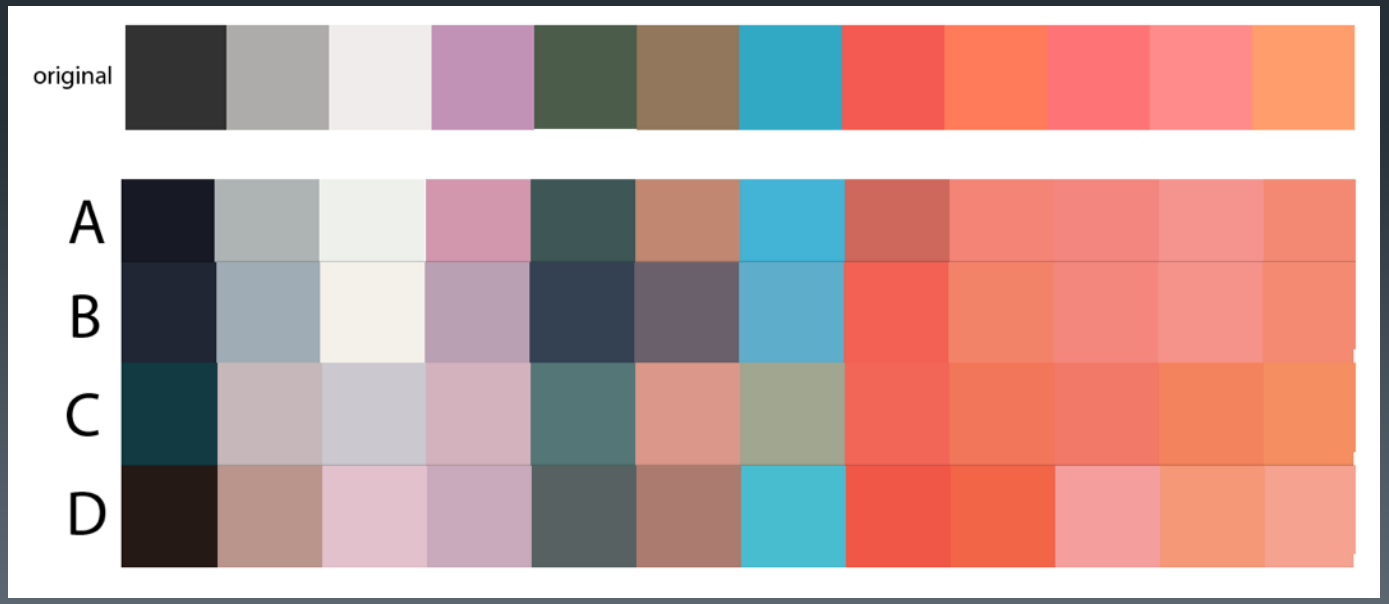
Quantified Changes

- Took what we knew of standard, and created our own profiles to remap colors to as close to standard as possible



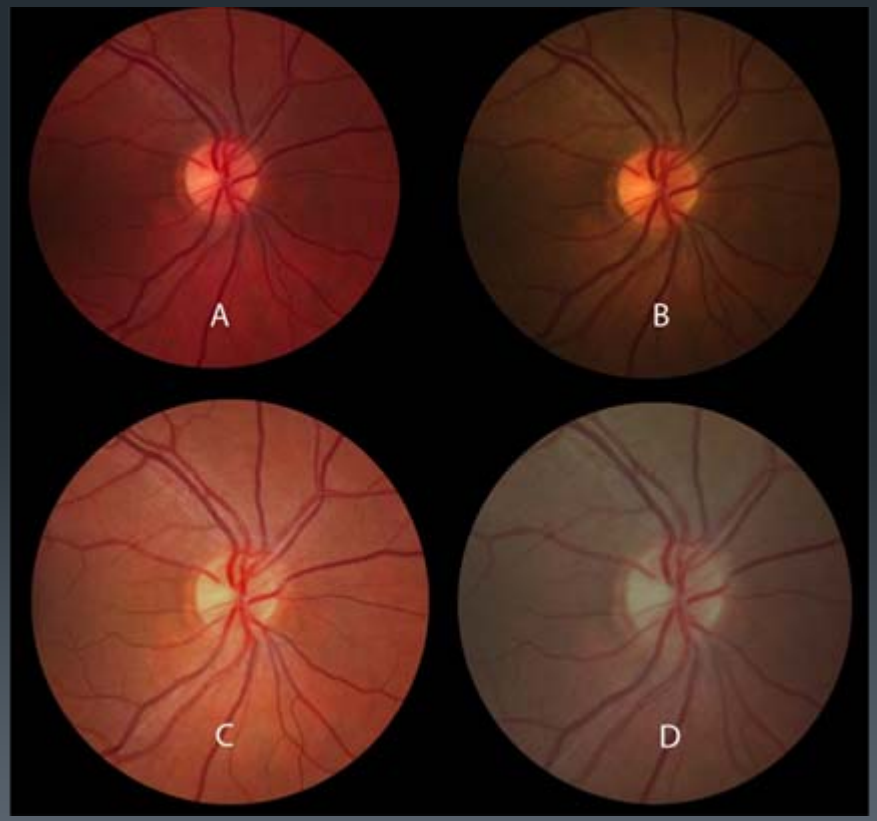
Before

After

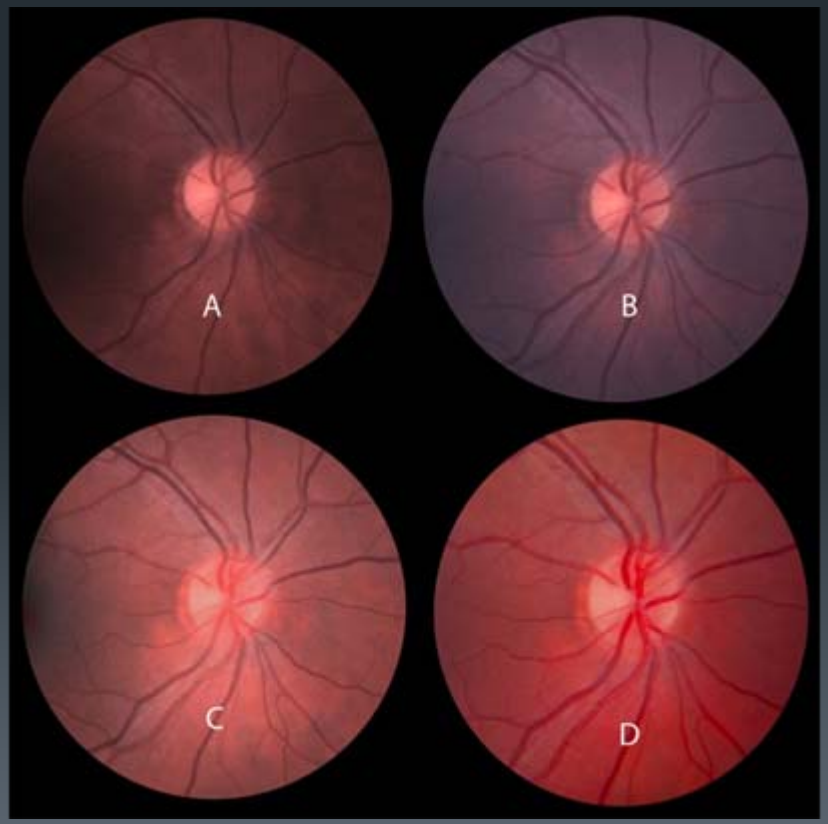


Images processed with created transforms for each camera

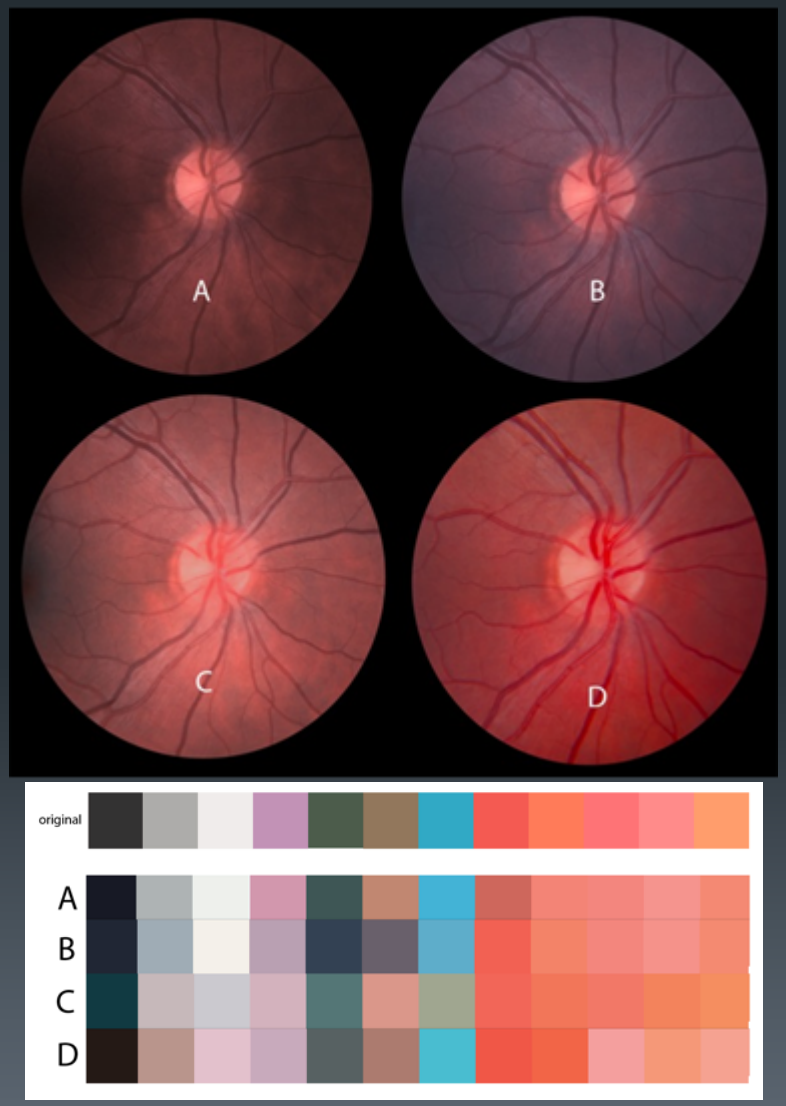
Before



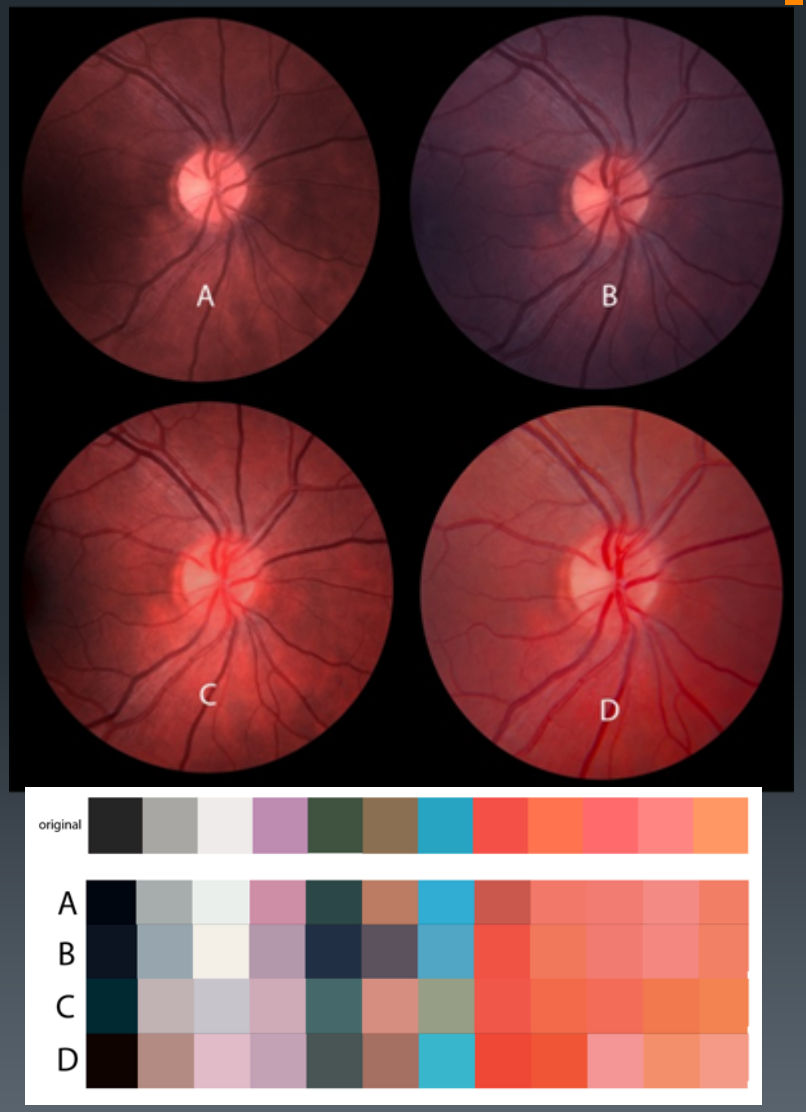
After



Reset Black Point

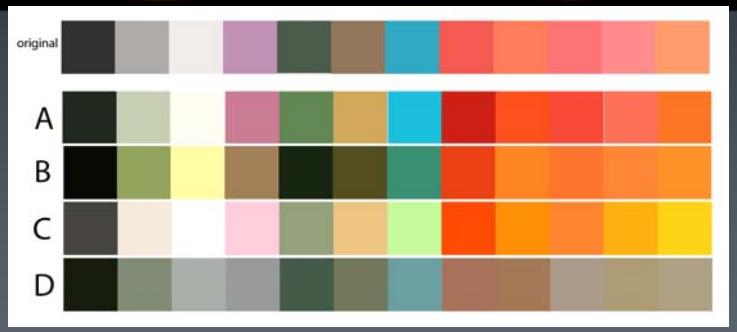


Before

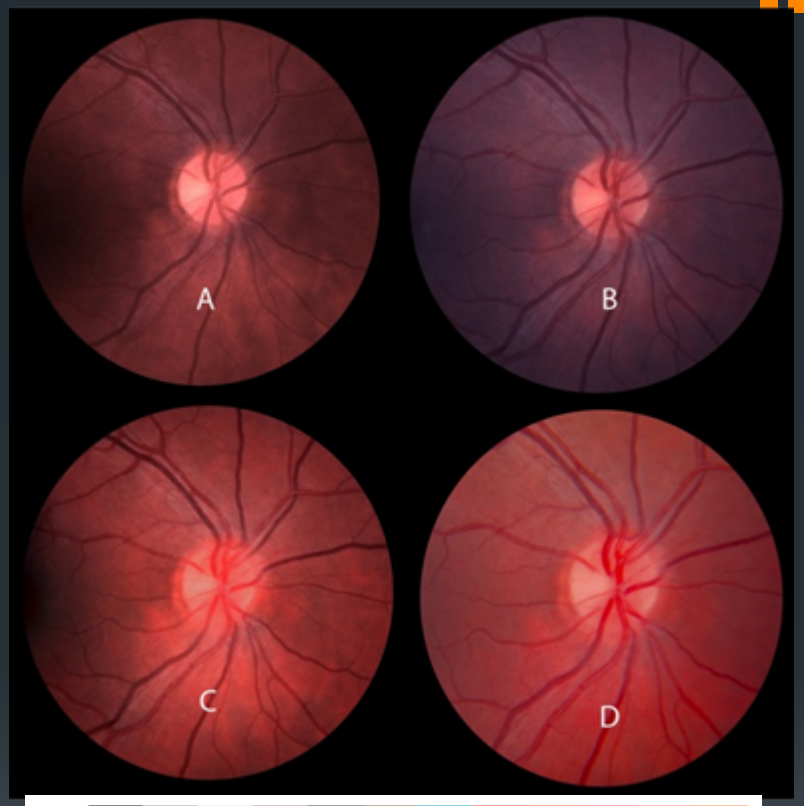


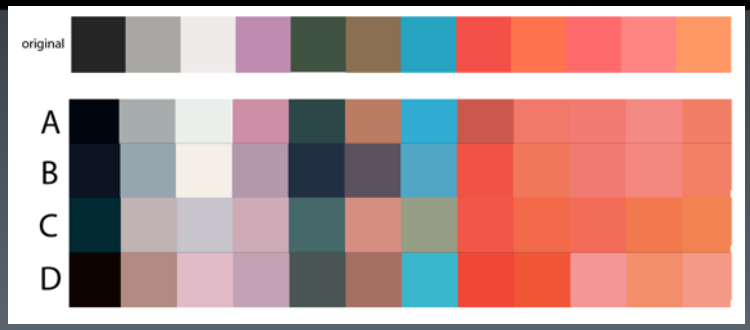
After

Captured vs. Processed



Before





After

Conclusions

- It is potentially possible to profile a fundus camera, at least individually
  - Applying to RAW image in system would be ideal
- What we as ophthalmic imagers and practitioners believe to be “correct” retinal color is not correct at all
- A standard approach to color calibration is needed to begin to regulate input variables

Thanks to:

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