

# Eye Colors and the Beautiful Science Behind It

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# Senses, Arts and Love



Beautiful Eyes. Luigi Maria de Rubeis. Saatchi Art, London

- Mapping internet use of “eye” and “colors”
  - Visual sense, anatomy
  - Social interactions
  - Arts, poetry

# Iris, the Divine Messenger



Gaetano Monti, 1841. Kunsthistorisches Museum, Vienna

- 'Rainbow' , 'Halo' (*gr.*)
- Mythological goddess of rainbow
- Carrier of Olympian deities' messages
- Child of Wonder (*gr.* 'Thaumas'), mother of Love ('Eros')

# Marble Eyes



Iris's Laborde Head, ca 447-432 BC, Louvre, Paris



Gaetano Monti, 1841. Kunsthistorisches Museum, Vienna

# Timeless Forms and Ephemeral Colors

- Neoclassicism's empty gazes
- White canvass where beholders' thoughts are projected



Belvedere's Apollo, ca 330-320 B.C. Vatican Museums



# Polychrome Eyes

- Since dawn of art history
- Plato: eyes the most important part of the body
- “Should be painted with the most beautiful color” (Tyrian purple)



Riace Men (detail), ca 460–450 BCE, Museo Nazionale di Reggio Calabria

# Colorful Eyes

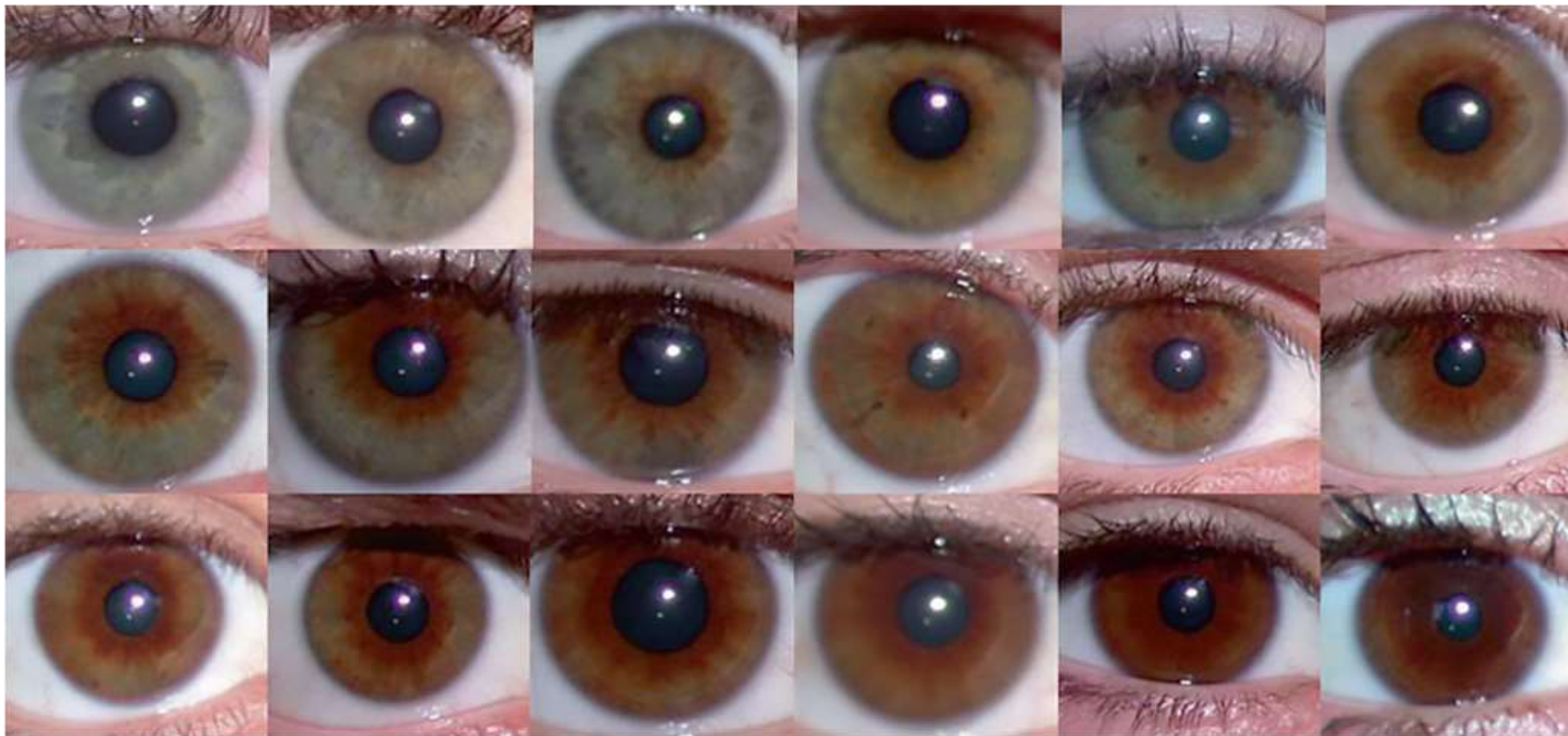


Pairs of Eyes, NY Metropolitan Museum of Art, New York



Statue of Athena, ca 4th century B.C. © Archaeological Museum of Piraeus

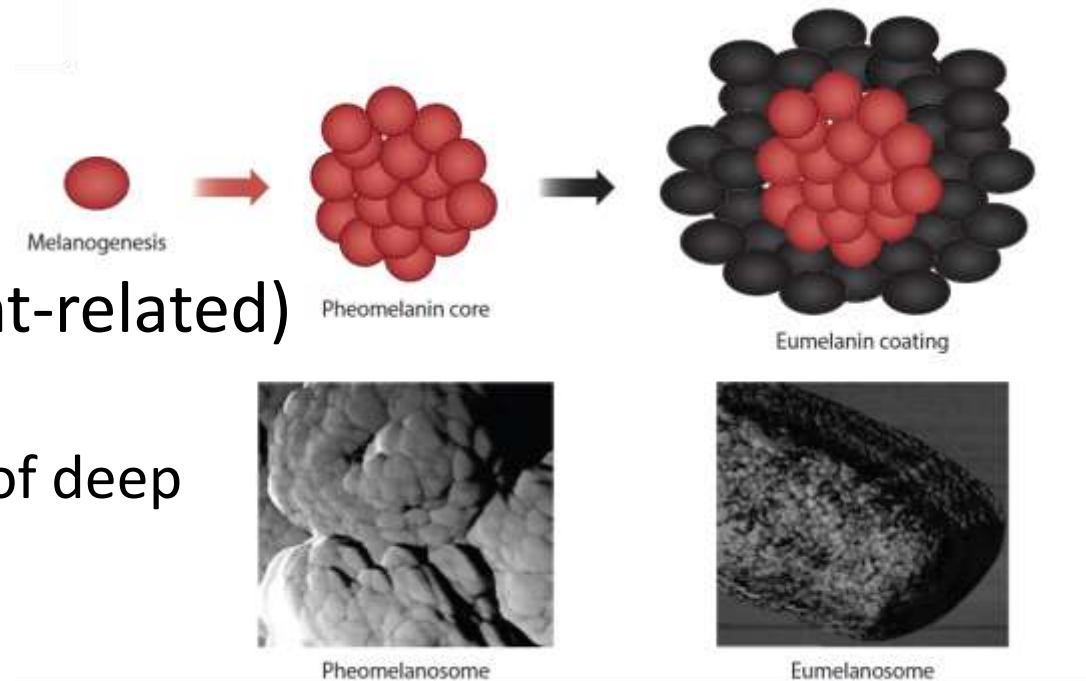
# Colorful Eyes



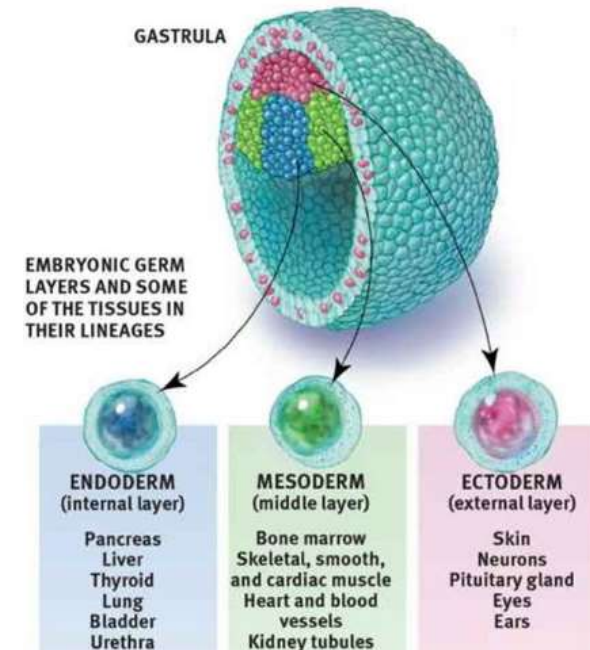
Mackey 2021. Eye (2022) 36:704–715

# Melanin and Right Diffraction in the Eye

- Light scattering
- Structural (not pigment-related) color
  - Similar to ocean-blue of deep waters
- Similar to oceans blue color



Pavan and Sturm 2019. An Rev Genom Human & Genet

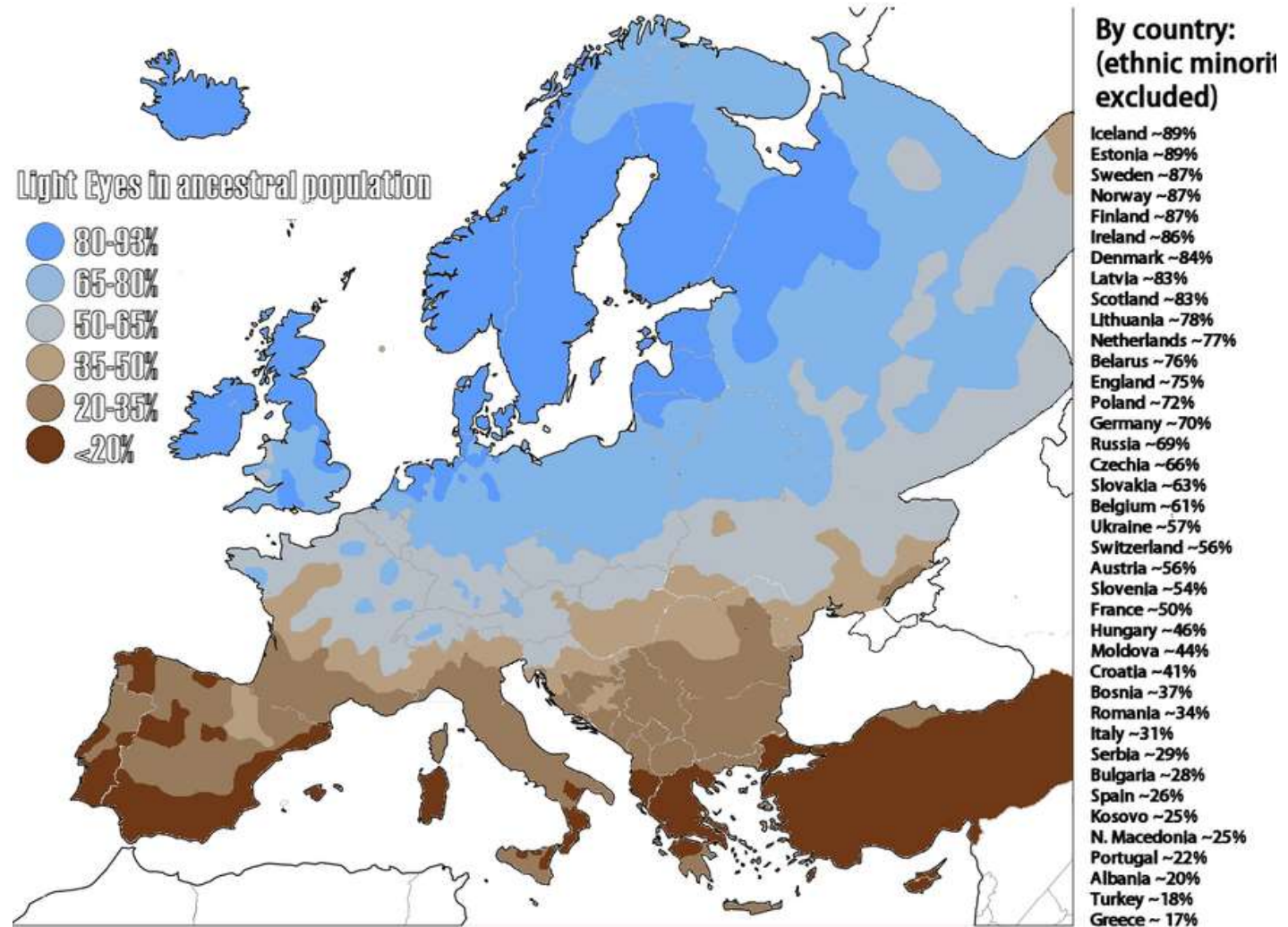




Blue eye distribution map, adaptation from Donnelly et al 2020, doi 10.1007/s00439-011-1110-x  
<https://www.thetech.org/ask-a-geneticist/articles/2022/do-asians-carry-blue-eyed-allele/>

# Mapping Eye Colors

- Lighter-darker changes in all populations
- Blue, green mostly (but not only) in Europeans



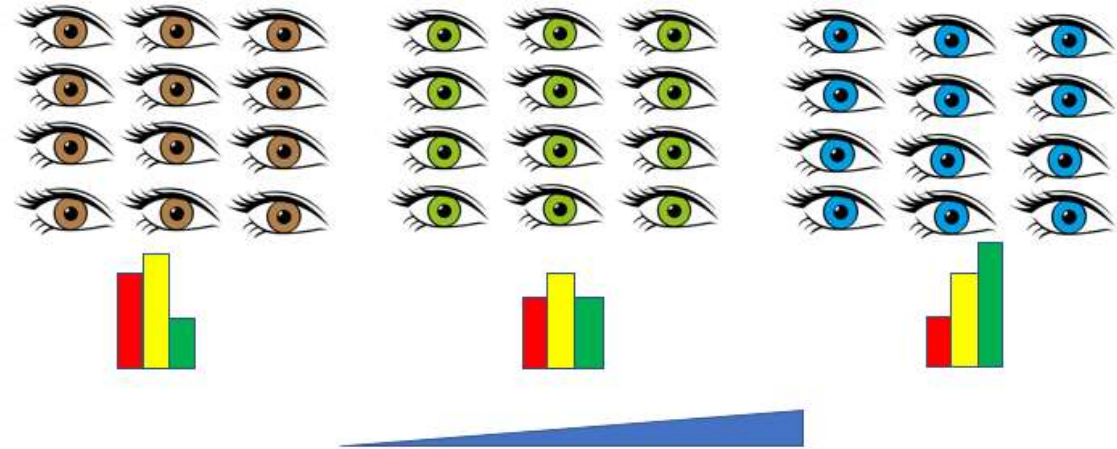
<https://justpaste.it/40dd8>

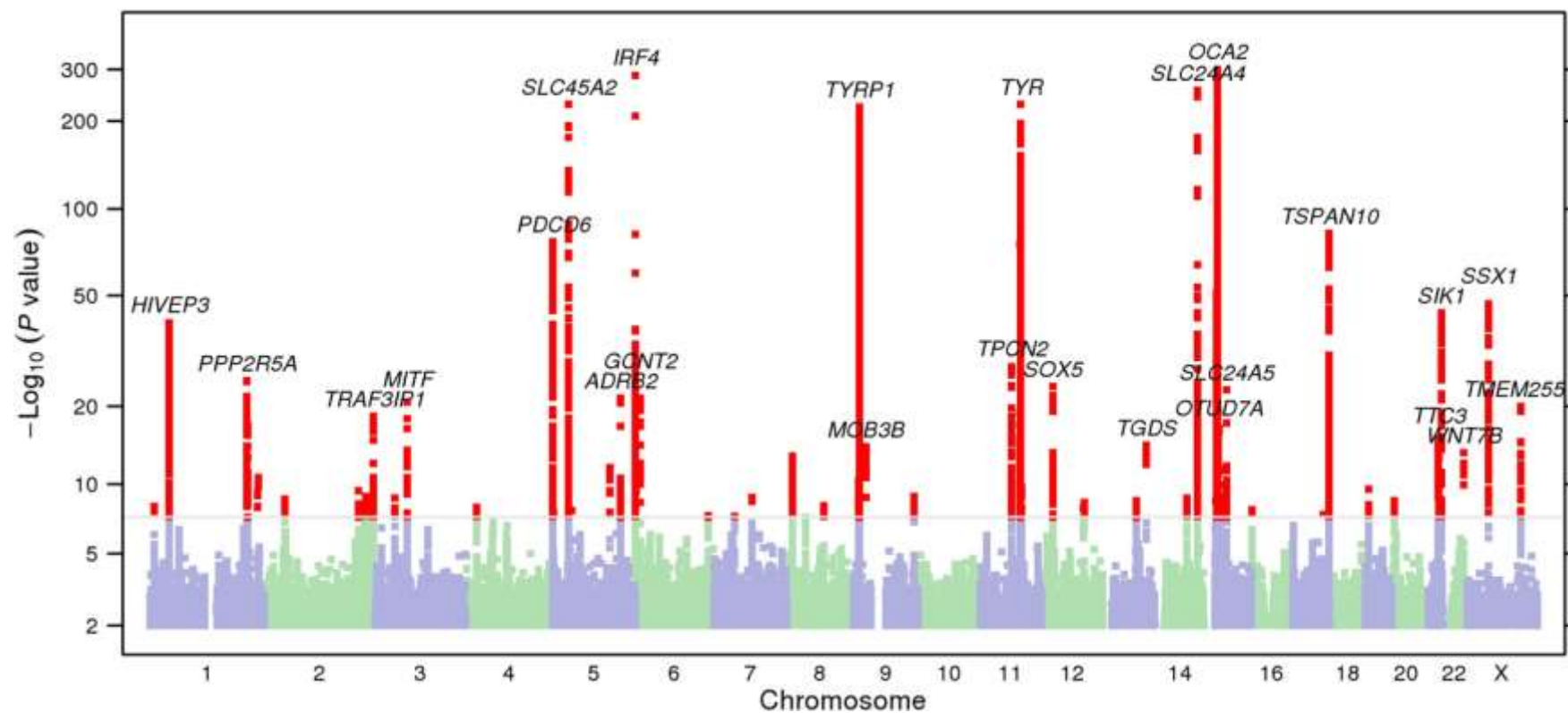
# Genetics, Heritability and Environment

- Famously ~ 100% heritable
  - Rare (~10%) cases of epigenetic mutations
- Bluer at birth, constant in 85-90% after age of 6
- Lighter in females compared to males

# Eye Color Genes

- GWAS: Compare eye color with the frequency of the changes
- Many (200,000) European volunteers

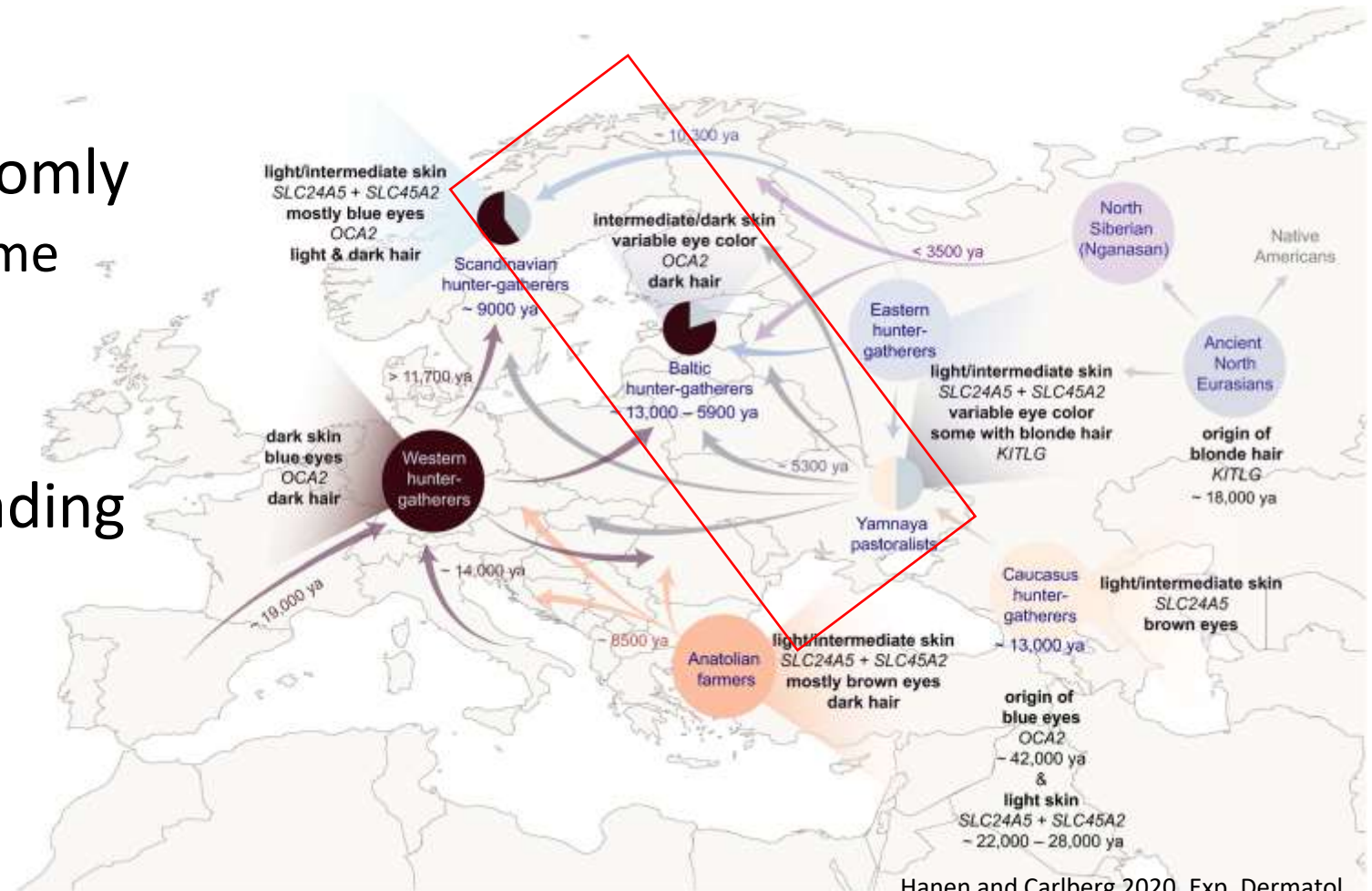




Simcoe et al 2021. Sci Adv

# Spreading of Blue Eyes Genes

- Mutations 'born' randomly
  - Several, at different time points
- If advantageous, spreading through populations
- Carried by migratory movements

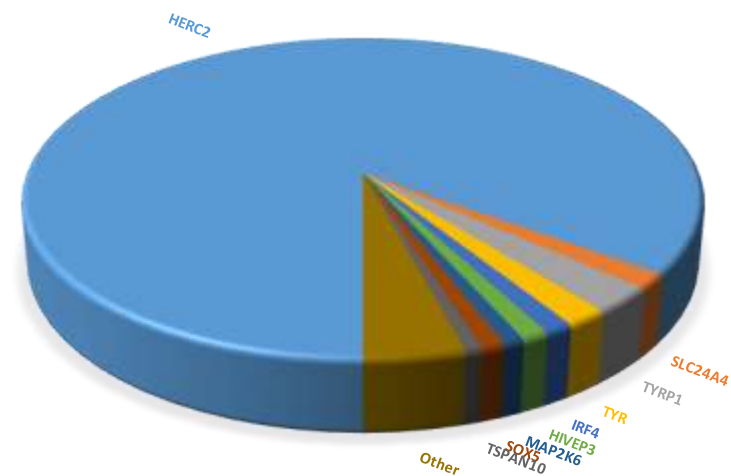


Hanan and Carlberg 2020. Exp. Dermatol.

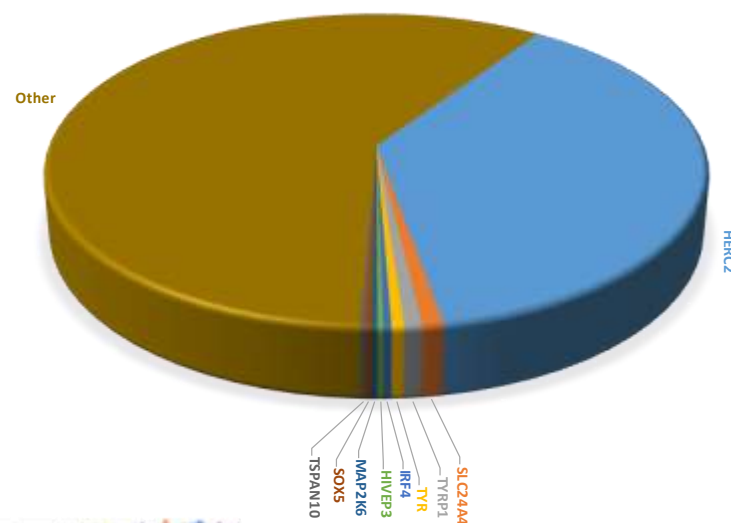
# OCA2 / HERC2

- The strongest effects inside *HERC2*
  - Controls *OCA2* function
- Several variants, predominantly in Europeans
- Loss-of-Function *OCA2* mutations cause type 2 oculocutaneous albinism
- Some variants independently determine blue vs. green

Blue vs all other eye color



All eye color across the bright (blue) to dark (brown) scale

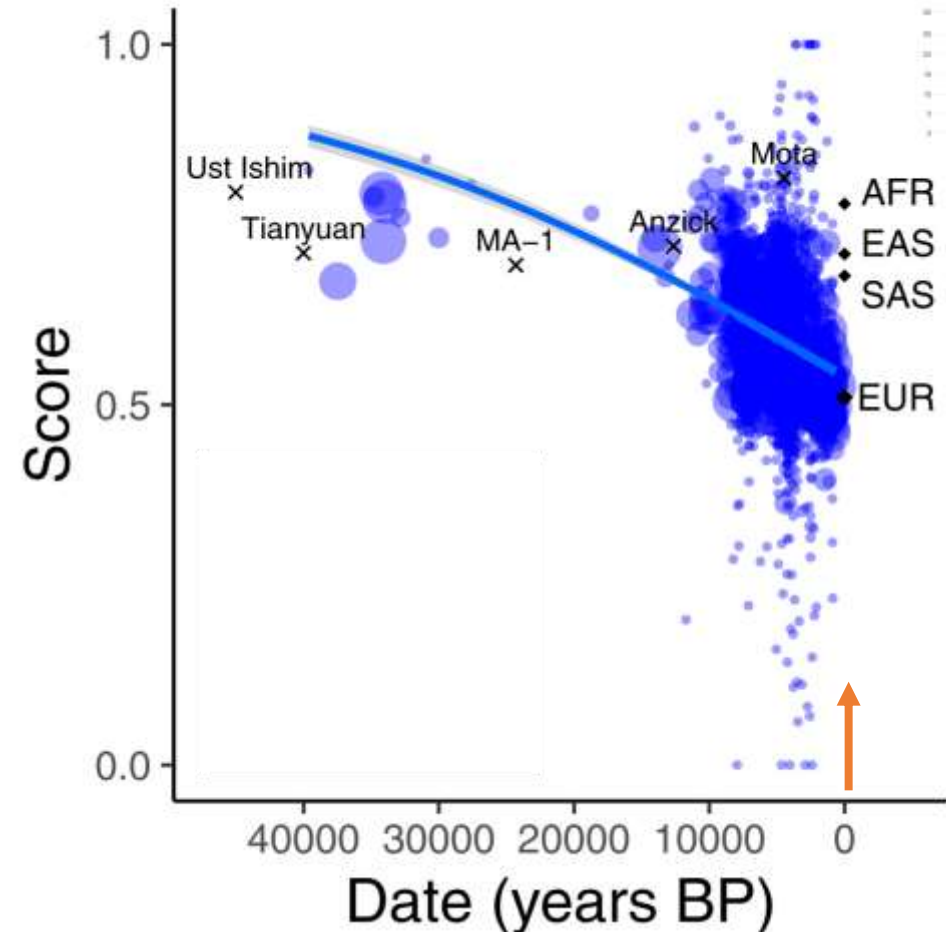


# Natural Selection

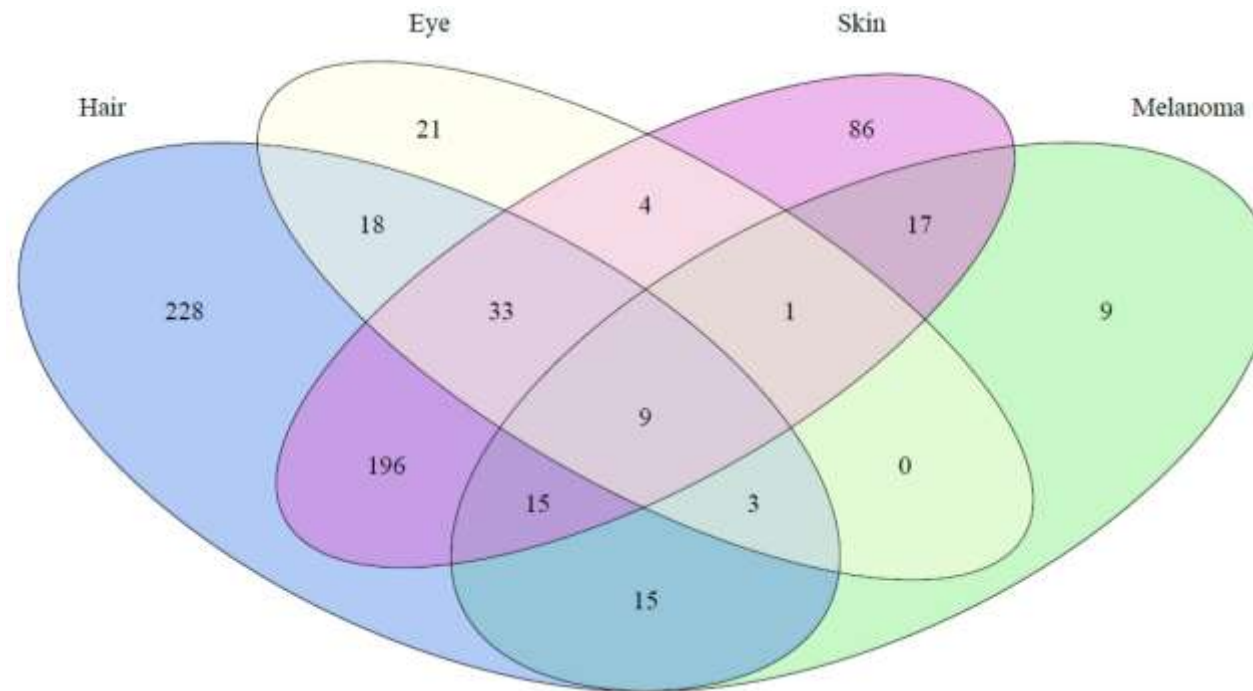
- European populations: 10 -15% of the world's all-trait genetic diversity
  - Yet over 80% of pigmentation genetic diversity
- About 850,000 years' worth of genetic variation for pigmentation genes
  - Europe only colonized ~35,000 years ago

# Evolution of Pigmentation Genes

- Ancient vs. modern DNA
- Lighter pigmented traits more common in recent Europeans
  - (lower scores)



# Eye Color and Other Pigmentation Traits



Zihe Xu, et al 2024

# Pleiotropy and Skin Color

- Effects over other (skin?) pigmentation
  - Vit D metabolism, especially in dim light conditions
  - Folate metabolism
- Increased barrier function in dry, hot environments
- More efficient microbial barrier



Hum Mol Genet. 2009;18(R1):R9-R17.



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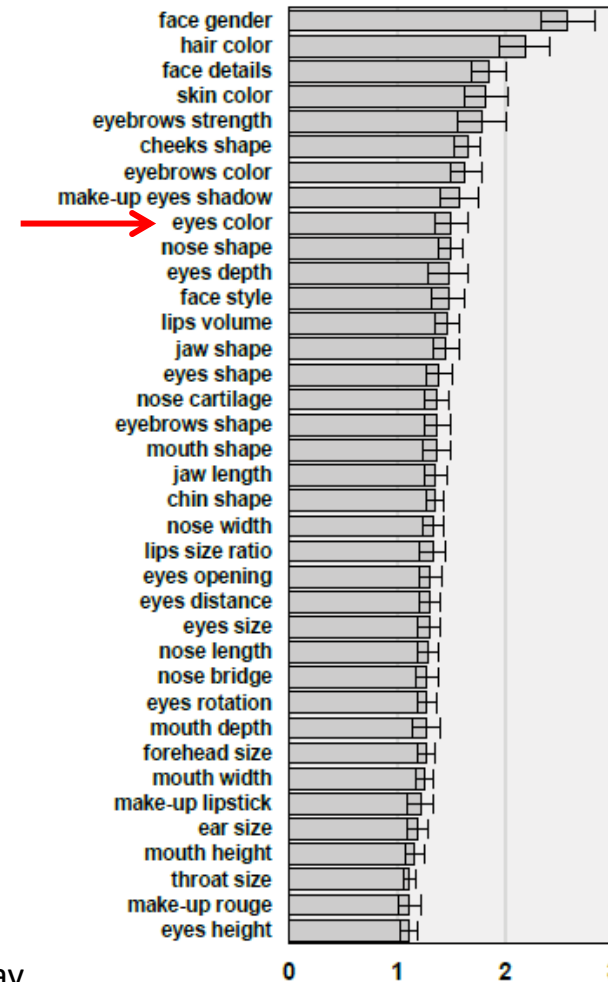
# Eye Color, Health and Disease

- Effects over vision
  - Bright eyes and acuity in dim lights
  - Energy absorption
- Disease associated with iris color
  - Cataract, AMD, Pigmentary Glaucoma, Alzheimer
  - Late onset – effect over reproductive fitness?
- Skin cancer
  - Melatonin
  - Tanning response

# Behavioral Factors and Natural Selection

- Eye color important in human interactions
  - Eyes as windows to the soul
- Likeability, trust relationship

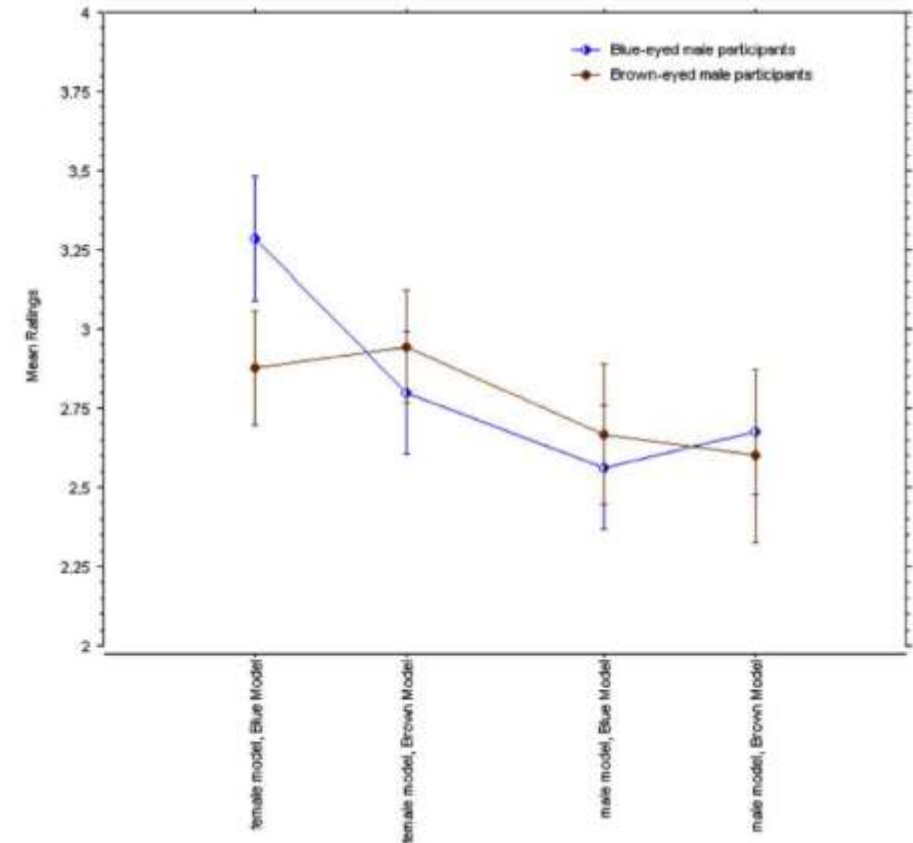
# Measuring Emotions: Uncanny Valley



Schwind et al. Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play

# Attractiveness and Sex-specific Selection

- Same eye color attraction
- Stronger effects for blue/green eyes



Laeng et al. 2007, Behav Ecol Sociobiol

# Iris Color in Hominoids



- Seven variants predicted to code for blue eyes
- Polymorphic, most with brown eyes but some with blue eyes
- One possibly surviving in modern day humans

# Blue Eyes Genes in Other Primates



Lemur



Spider Monkey



Japanese Snow Monkey

# Timeless Eyes (Instead of a Conclusion)



Metronome, Emmanuel Radnitzky (Ray Man)  
1957 remake. Tirana National Museum.  
Courtesy: Giorgio Baltassare

- Ephemeral art, eternal love
- “Indestructible Object” (1957)
- Not simply in the eye of the beholder

# Special Thanks to

- Our KCL Group, particularly
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  - Fight for Sight, UK
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