

Skin Color in Human Evolution

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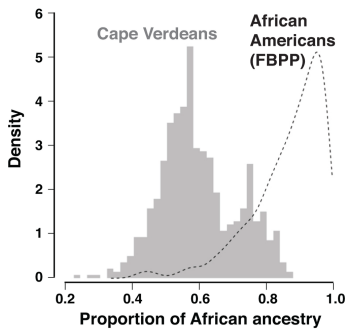
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Cape Verde Islands

A good place to study genetic variation in skin color.

Why Cape Verde is ideal



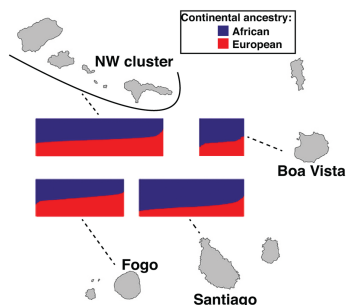
Population is close to a 50:50 mixture of African and European ancestry.

Lots of variation at loci that differ between the continents.

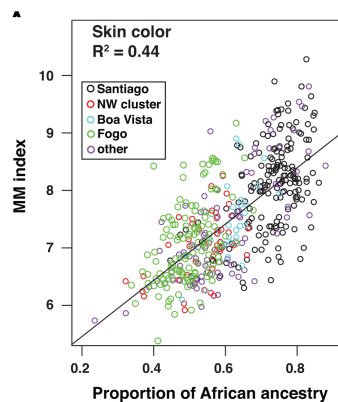
African Americans (dotted lines) are much more African.



Genome-wide association study (GWAS) of skin color



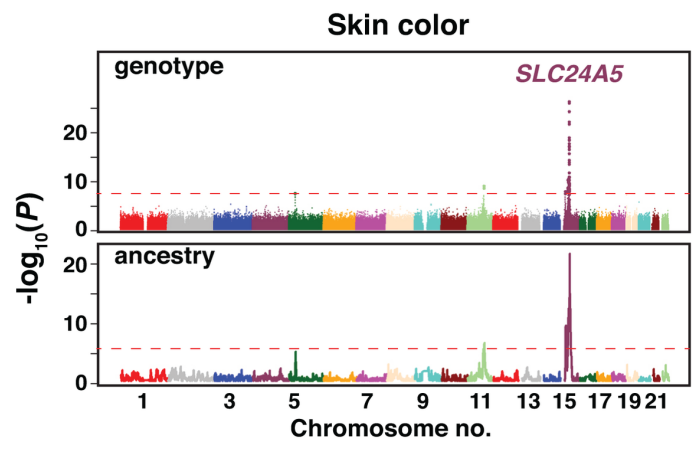
- ▶ GWAS: look for loci associated with skin color
- ▶ Beleza et al (2013).



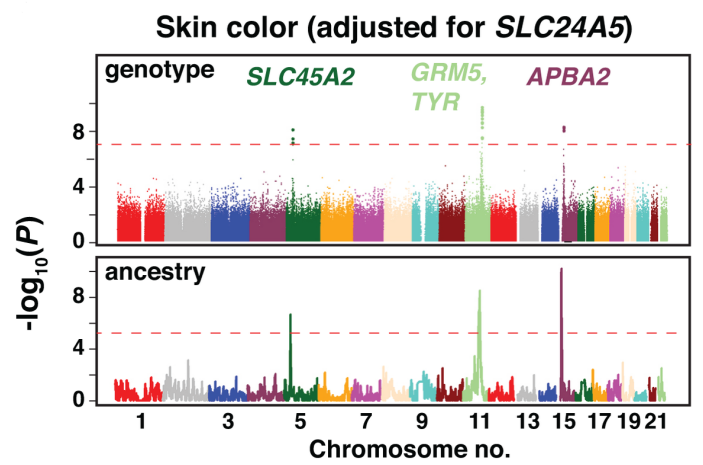
Skin color varies with African Ancestry

Colors indicate the various islands.

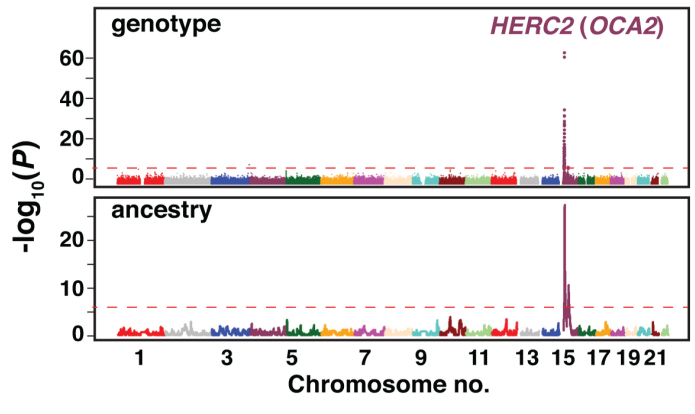
Locus SLC24A5 affects skin color



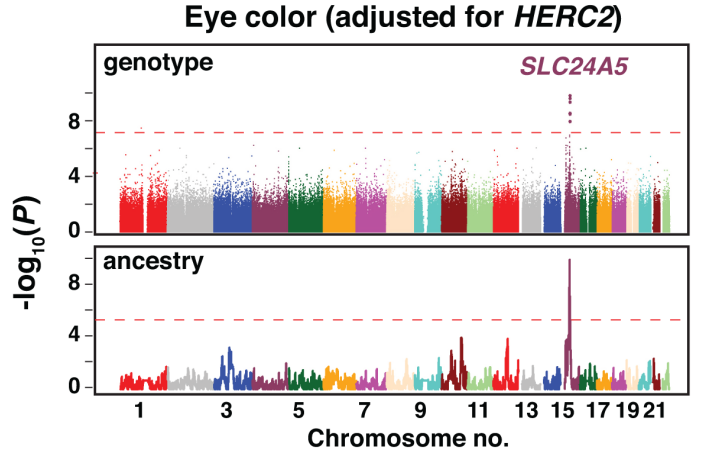
3 other loci pop out after adjusting for SLC24A5



Locus HERC2 affects eye color



SLC24A5 affects eyes as well as skin

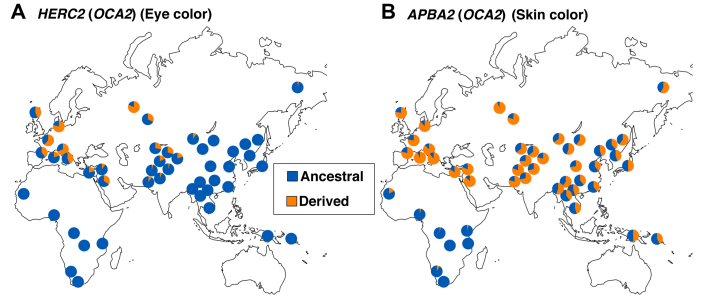


How these genes work

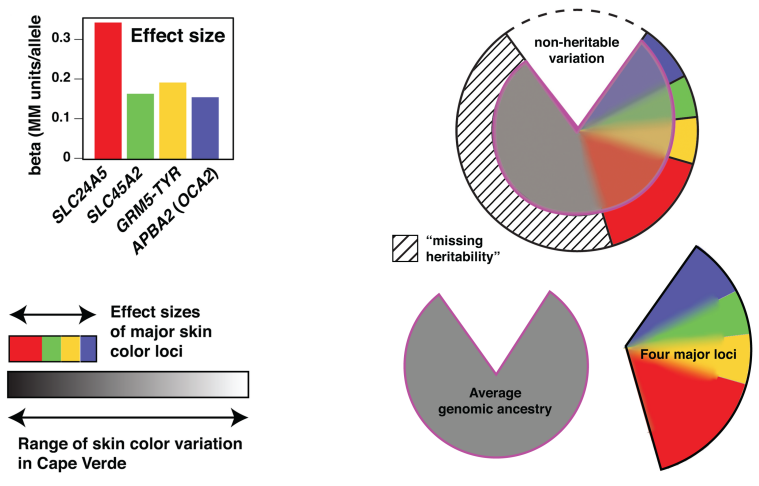
Mutant forms of SLC45A2 and SLC24A5 are expressed in pigment cells and reduce synthesis of melanin.

The other mutations seem to be in regulatory regions upstream from genes that affect skin color.

Geographic distribution of derived alleles



Missing heritability



La Braña, a 7000-y-old Mesolithic European



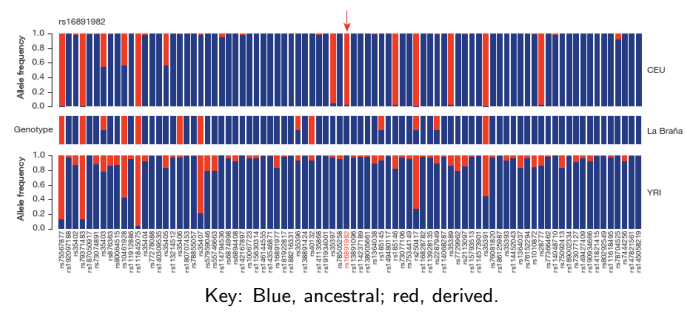
Mesolithic Europeans: dark skin & blue eyes



Dark skin: Ancestral (dark-skin) allele at SLC45A2, SLC24A5, MC1R, TYR and KITLG. Derived (light-skin) alleles at TYRP1, ASIP and IRF4.

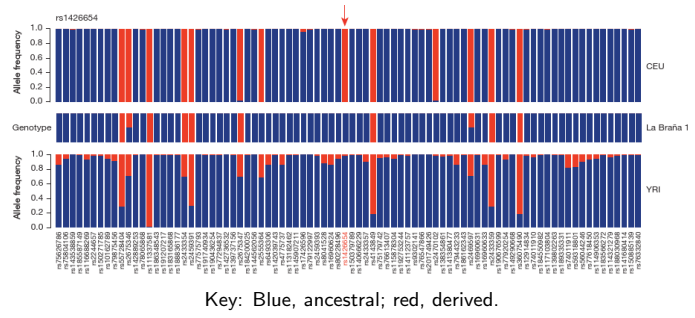
Blue eyes: Derived (blue-eye) allele at HERC2.

Ancestral variants around SLC45A2



Modern Europeans (CEU) have derived alleles at several sites where La Braña and Africans (YRI) are ancestral. La Braña preceded the evolution these alleles.

Ancestral variants around SLC24A5

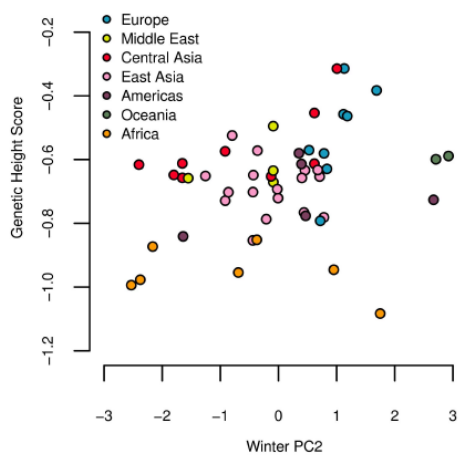


Same interpretation as above.

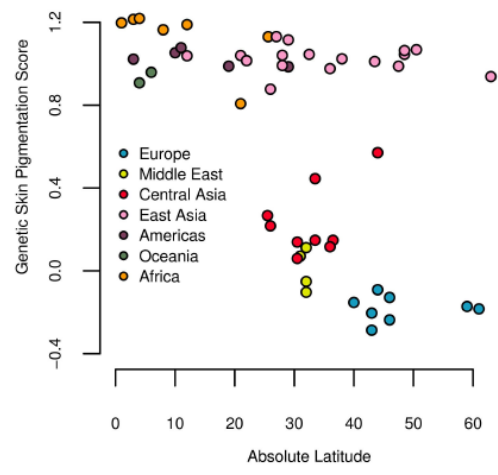
Study of Berg and Coop (2014)

- ▶ GWAS (Beleza et al 2013) provides a list of alleles that affect skin color and estimates magnitude of these effects.
- ▶ My "genetic skin color" is the sum of effects of my skin-color alleles. (Called a "polygenic score.")
- ▶ Not necessarily the same as my real skin color.
- ▶ Do skin-color alleles vary in the same way as non-functional DNA? If not, the data will tell us about selection.

Genetic stature responds to variation in climate

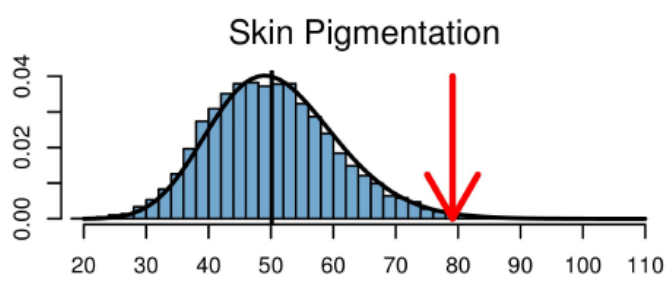


Genetic skin color varies with latitude



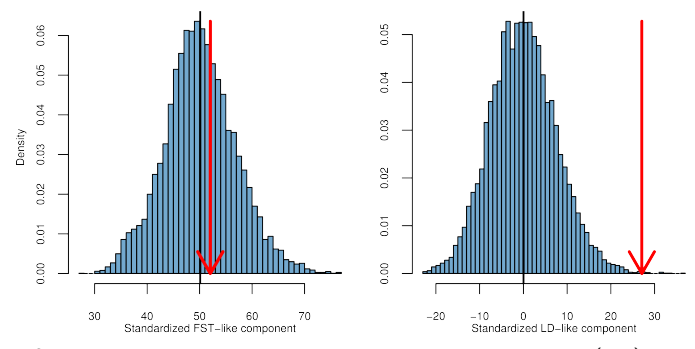
Dark skin in low latitudes.
 Light skin in high latitudes.
 Why do Asians carry alleles for dark skin?
 They evolved light skin independently, using different alleles.

Skin color does not evolve neutrally



Histogram shows distribution of a test statistic with neutral DNA.
 Red arrow shows value for skin-color alleles.

The signal of selection is mainly in LD



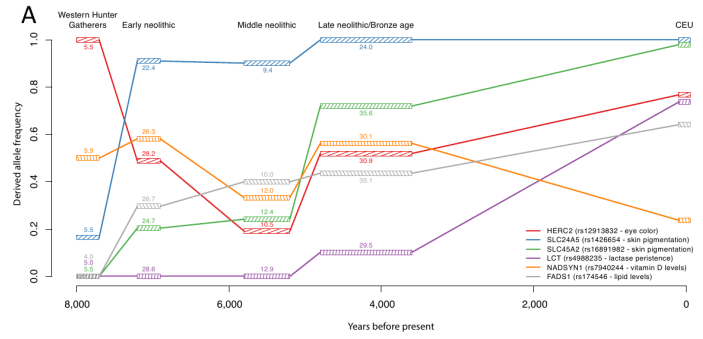
Left, variation within loci; right, associations among loci (LD).

We need to look at associations among loci.

Study of Mathieson et al 2015

- ▶ DNA from 83 ancient Europeans.
- ▶ Track changes in allele frequencies over time.

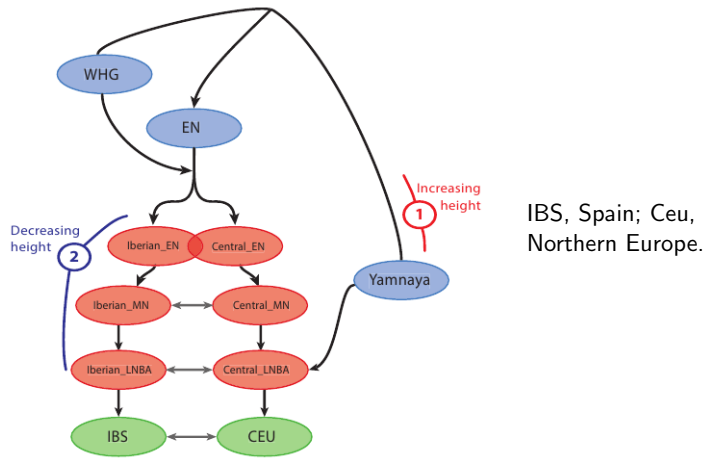
History of evolution in Europe



Eye color Blue eyes early; brown with Neolithic; blue comes back 4 kya.

Skin color Dark early; lighter with Neolithic; lighter still 4 kya.

Graphical summary



Summary

- ▶ A small number of loci accounts for about half the genetic variance in skin color.
- ▶ The rest—presumably many loci with individually-small effects.
- ▶ Asians and Europeans evolved light skin independently.
- ▶ The signal of selection is mainly in associations among loci (LD).
- ▶ Mesolithic Europeans had blue eyes; brown eyes arrived with the Neolithic; then blue again in 4 kya.
- ▶ Mesolithic Europeans had dark skin; got lighter during Neolithic and lighter still about 4 kya.