

Supporting Information

von Cramon-Taubadel 10.1073/pnas.1113050108

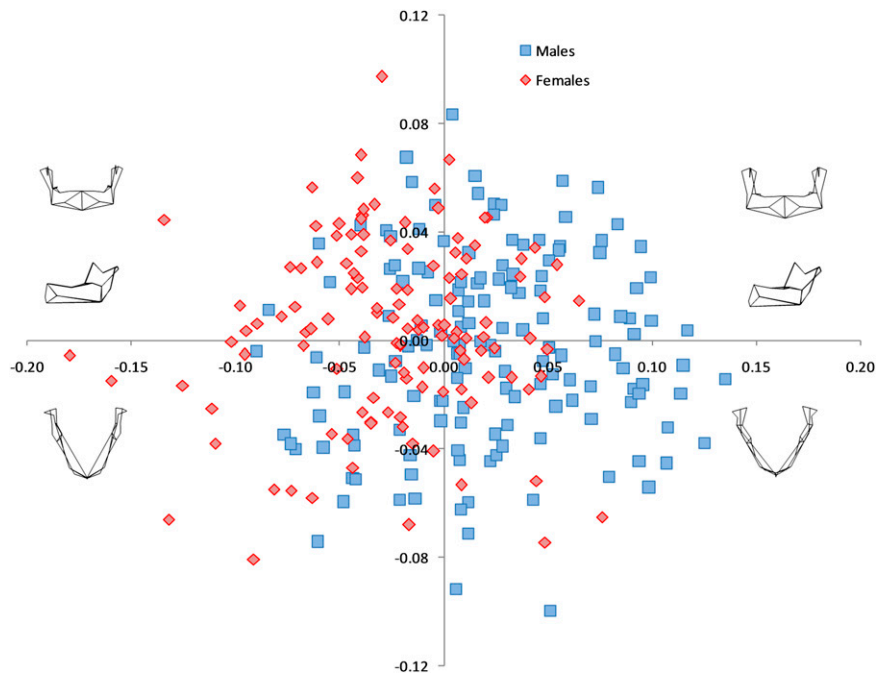


Fig. S1. Analysis of sexual dimorphism. PCA of form (rescaled Procrustes variables). Shape changes on PC1 (34.8% variance explained) associated with changes in isometric scaling are shown via the average wireframes at the ends of PC1. Males and females are significantly different on PC1 ($P < 0.0001$). The shape changes associated with male sexual dimorphism are a more flared and angled gonial region, a more pronounced chin (pogonion), and a steeper and more upright corpus.

Table S1. Classical marker frequency data for the 11 populations sampled*

Loci	<i>ABO</i>			<i>HLA-A</i>																<i>HLA-B</i>				
	<i>A</i>	<i>B</i>	<i>O</i>	1	2	3	9	10	11	19	23	24	25	26	28	29	30	31	32	33	5	7	8	
Alaskan	0.39	0.10	0.51	0.01	0.13	0.00	0.68	0.00	0.00	0.05	0.00	0.20	0.00	0.00	0.14	0.00	0.00	0.04	0.00	0.01	0.13	0.01	0.01	
Australian	0.28	0.00	0.72	0.00	0.17	0.00	0.25	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Chinese	0.21	0.19	0.60	0.02	0.31	0.02	0.19	0.02	0.03	0.16	0.00	0.19	0.00	0.02	0.00	0.01	0.03	0.03	0.01	0.05	0.08	0.02	0.01	
Greenland	0.29	0.06	0.65	0.03	0.20	0.02	0.59	0.01	0.02	0.12	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.11	0.02	0.02		
Hawikuh	0.09	0.00	0.91	0.00	0.50	0.01	0.36	0.00	0.00	0.08	0.00	0.36	0.00	0.00	0.00	0.00	0.04	0.00	0.04	0.08	0.01	0.00		
Ibo	0.13	0.13	0.74	0.02	0.15	0.10	0.10	0.01	0.00	0.35	0.10	0.00	0.00	0.01	0.10	0.03	0.11	0.04	0.01	0.13	0.02	0.07	0.00	
Italian	0.26	0.07	0.67	0.13	0.26	0.13	0.13	0.07	0.07	0.07	0.01	0.06	0.01	0.03	0.04	0.03	0.01	0.01	0.04	0.01	0.12	0.06	0.07	
Japanese	0.28	0.18	0.54	0.00	0.21	0.00	0.42	0.13	0.04	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.26	0.04	0.03		
Mongolian	0.17	0.23	0.10	0.29	0.08	0.31	0.03	0.06	0.05	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.11	0.07	0.03		
Central African	0.19	0.13	0.68	0.00	0.13	0.10	0.13	0.05	0.00	0.19	0.00	0.00	0.00	0.04	0.05	0.06	0.01	0.01	0.02	0.03	0.05	0.02		
San	0.19	0.05	0.76	0.05	0.15	0.05	0.17	0.02	0.00	0.43	0.06	0.11	0.02	0.00	0.08	0.06	0.14	0.06	0.10	0.07	0.09	0.11	0.04	

Loci	<i>HLA-B</i>																					
	12	13	14	15	16	17	18	21	22	27	35	37	38	39	40	41	44	49	51	62	63	
Alaskan	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.13	0.12	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.05	0.13	0.01	
Australian	0.00	0.07	0.00	0.07	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.00	0.00	0.00	
Chinese	0.03	0.11	0.00	0.13	0.04	0.07	0.00	0.00	0.07	0.00	0.03	0.01	0.01	0.01	0.22	0.00	0.00	0.00	0.00	0.00	0.00	
Greenland	0.03	0.00	0.00	0.22	0.01	0.01	0.00	0.00	0.13	0.09	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Hawikuh	0.00	0.00	0.01	0.00	0.12	0.00	0.00	0.10	0.00	0.00	0.10	0.00	0.00	0.06	0.20	0.00	0.00	0.00	0.00	0.00	0.00	
Ibo	0.08	0.01	0.00	0.04	0.02	0.18	0.05	0.04	0.00	0.00	0.06	0.01	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	
Italian	0.10	0.03	0.03	0.04	0.06	0.03	0.09	0.04	0.02	0.01	0.17	0.01	0.01	0.01	0.03	0.00	0.03	0.01	0.02	0.01	0.00	
Japanese	0.07	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	
Mongolian	0.07	0.04	0.00	0.06	0.00	0.11	0.02	0.05	0.02	0.00	0.07	0.00	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	
Central African	0.10	0.01	0.02	0.00	0.05	0.08	0.02	0.01	0.01	0.00	0.05	0.03	0.00	0.05	0.04	0.00	0.00	0.00	0.00	0.00	0.00	
San	0.07	0.02	0.00	0.10	0.03	0.22	0.06	0.00	0.02	0.00	0.02	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	

Loci	<i>HP†</i>		<i>IGHG1G3†</i>		<i>KEL</i>	<i>KM</i>	<i>MN†</i>		<i>P</i>	<i>PGD†</i>		<i>PGM1</i>	<i>RH</i>								
	1	2	<i>za;g</i>	<i>zaxg</i>	<i>K</i>	1	<i>M</i>	<i>N</i>	<i>P1</i>	<i>A</i>	<i>C</i>	1	<i>CDE</i>	<i>CDe</i>	<i>CdE</i>	<i>Cde</i>	<i>cDE</i>	<i>cDe</i>	<i>cdE</i>	<i>cde</i>	
Australian	0.31	0.69	0.86	0.03	0.00	0.32	0.84	0.16	0.17	1.00	0.00	0.85	0.00	0.45	0.00	0.00	0.53	0.02	0.00	0.00	
Alaskan	0.23	0.77	0.71	0.25	0.00	0.21	0.26	0.75	0.25	0.96	0.04	0.90	0.06	0.61	0.00	0.01	0.24	0.08	0.00	0.00	
Chinese	0.27	0.73	0.40	0.17	0.00	0.34	0.56	0.45	0.06	0.94	0.06	0.77	0.01	0.74	0.00	0.02	0.17	0.02	0.00	0.05	
Greenland	0.35	0.65	0.76	0.01	0.00	0.19	0.76	0.24	0.14	0.99	0.01	0.66	0.01	0.65	0.00	0.00	0.29	0.03	0.00	0.02	
Hawikuh	0.54	0.47	0.91	0.06	0.00	0.34	0.70	0.30	0.54	1.00	0.00	0.83	0.03	0.55	0.00	0.00	0.35	0.08	0.00	0.00	
Ibo	0.68	0.32	0.00	0.00	0.01	0.37	0.47	0.53	0.76	0.95	0.06	0.76	0.01	0.07	0.00	0.03	0.07	0.60	0.00	0.23	
Italian	0.37	0.63	0.15	0.04	0.04	0.09	0.56	0.45	0.51	0.98	0.02	0.72	0.00	0.46	0.01	0.03	0.12	0.03	0.01	0.36	
Japanese	0.21	0.79	0.55	0.17	0.05	0.31	0.53	0.47	0.17	0.92	0.08	0.82	0.05	0.57	0.00	0.05	0.11	0.05	0.05	0.12	
Mongolian	0.27	0.73	0.43	0.10	0.00	0.07	0.55	0.45	0.19	0.88	0.12	0.76	0.03	0.54	0.00	0.00	0.20	0.11	0.00	0.13	
Central African	0.37	0.64	0.00	0.00	0.02	0.36	0.56	0.45	0.77	0.99	0.01	0.85	0.00	0.01	0.00	0.03	0.01	0.83	0.00	0.12	
San	0.32	0.68	0.14	0.00	0.05	0.37	0.56	0.44	0.79	1.00	0.00	0.94	0.00	0.06	0.00	0.00	0.02	0.86	0.00	0.07	

*Data collated from Cavalli-Sforza et al. (1).

†In the case of biallelic markers, only one allele frequency was used to generate the genetic distance matrix.

1. Cavalli-Sforza LL, Menozzi P, Piazza A (1994) *The History and Geography of Human Genes* (Princeton Univ Press, Princeton).

Table S2. Anatomical descriptions of all landmarks used

Landmark	Anatomical definition	Source	Configuration
Cranial unilateral			
Alveolon	Point where the interpalatal suture intersects the line joining the posterior margins of the alveolar process	(1)	P
Basion	Point where the anterior margin of the foramen magnum intersects the midsagittal plane	(1)	C
Bregma	Point where the coronal and sagittal sutures intersect	(1)	V
Glabella	Most anterior midline point on the frontal bone	(1)	V
Hormion	Point of attachment of the vomer and sphenoid bones	(1)	C
Incisivon	Most posterior inferior point on the incisive fossa		P
Inion	Point where the superior nuchal lines merge in the external occipital protuberance	(1)	C, V
Lambda	Point where the sagittal and lambdoid sutures intersect.	(1)	V
Metopion	Point where the frontal elevation above the chord from nasion-bregma is greatest	(1)	V
Nasion	Point of intersection of the nasofrontal suture and the midsagittal plane.	(1)	
Opisthion	Point where the posterior margin of the foramen magnum intersects the midsagittal plane	(1)	C
Opisthocranium	Most posterior midline point, which lies at the farthest chord length from glabella	(1)	V
Orale	Point of intersection on the palate with a line tangent to the posterior margins of the central incisor alveoli	(1)	P
Palatomaxillare	Point of intersection of the palatine and the maxillary bones	(2)	P
Parietal subtense	Where the sagittal elevation above the chord from bregma-lambda is greatest	(3)*	V
Prosthion	Most anterior point on the maxillary alveolar process between the two central incisors	(1)	P
Sphenobasion	Midline point on the sphenoccipital suture	(1)	C
Staphylon	Point where the interpalatal suture intersects a line joining the deepest indentation of the posterior palate	(1)	P
Subspinale	Point at which the inferior edge of the nasal spine becomes the anterior edge of the maxilla	(1)	P
Cranial bilateral			
Alare	Most lateral point on the nasal aperture taken perpendicular to the nasal height	(4)	
Alveolare	Most anterior point on the alveolus of the first molar	(3)*	P
Asterion	Point where the lambdoid, parietomastoid, and occipitomastoid sutures meet	(1)	C, V
C/P3	Most inferior external point between the maxillary canine and the first premolar	(2)	P
Carotid canal (lat)	Most lateral point on the carotid canal		C
Carotid canal (med)	Most medial point on the carotid canal		C
Coronale	Most lateral point on the coronal suture	(1)	V
Cheek height (sup)	Point on the inferior orbital rim that represents the endpoint of minimum cheek height	(3)*	Z
Cheek height (inf)	Point on the inferior border of the zygomatic that represents the end point of minimum cheek height	(3)*	Z
Dacryon	Point of intersection of the frontolacrimal and lacrimomaxillary sutures	(1)	
Ectoconchion	Most lateral point on the orbital margin	(1)	Z
Ectomolare	Most lateral point on the outer surface of the alveolar margin of the maxilla	(1)	P
External aud meatus (ant)	Most anterior point on the margin of the external auditory meatus		V
External aud meatus (inf)	Most inferior point on the margin of the external auditory meatus	(2)	V
External aud meatus (pos)	Most posterior point on the margin of the external auditory meatus		V
External palate length	Point on the inferior surface of the maxilla that denotes the most posterior point of the alveolar process	(2)	P
Foramen magnum (lat)	Most lateral point on the margin of the foramen magnum	(2)	C
Foramen ovale (ant)	Most anterior point on the foramen ovale		V
Foramen ovale (pos)	Most posterior point on the foramen ovale		V
FRED	Point of intersection of the frontozygomatic, zygomaticosphenoid, and sphenofrontal sutures		V, Z
Frontomalare orbitale	Point where the zygomaticofrontal suture crosses the orbital margin	(1)	Z
Frontomalare temporale	Most lateral point on the zygomaticofrontal suture	(1)	Z
Frontotemporale	Point on the frontal bone where the temporal line reaches its most anteromedial position	(1)	V, TL

Table S2. Cont.

Landmark	Anatomical definition	Source	Configuration
Hormion (lat)	Most posterior point on the ala of the vomer		C
Hypoglossal foramen	Most superior, anterior point on the edge of the hypoglossal canal		C
Infranasion	Point of intersection of the nasofrontal, nasomaxillary, and maxillofrontal sutures	(1)	
Jugale	Point in the notch between the temporal and frontal processes of the zygomatic bone	(1)	Z
Jugular (lat)	Most inferior, lateral point on the margin of the jugular foramen	(5)	C
Jugular (med)	Most inferior, medial point on the margin of the jugular foramen		C
Krotaphion	Most posterior extent of the sphenoparietal suture	(1)	V
Mandibular fossa (lat)	Most lateral point on the mandibular fossa	(5)*	V, Z
Mastoideale	Most inferior, lateral point on the mastoid process	(1)	C
Mastoideale (ant)	Anterior point of intersection of the mastoid process and the external tympanic plate	(3)*	C
Mastoideale (pos)	Posterior point of intersection of the mastoid process and the digastric groove	(3)*	C
Mastoideale (sup)	Most superior, lateral point on the mastoid process (on the FH)	(3) ^a	C, V
Maximum maxillary curve	Point in the depth of the notch between the zygomaxillary suture and the alveolar process	(2)	P
Molars (pos)	Most inferior, posterior point on the external maxillary alveolus (pos to third molars)	(2)	P
Nariale	Most inferior point on the lower rim of the nasal aperture	(3)*, (6)	
Nasomaxillare	Most inferior point on the nasomaxillary suture	(2)	
Occipitocondyle (ant)	Most anterior, inferior point on the occipital condyle		C
Occipitocondyle (lat)	Most lateral, inferior point on the occipital condyle		C
Orbitale	Most inferior midpoint on the orbital margin	(1)	Z
Orbitale (sup)	Most superior midpoint of the orbital margin		
Palatomaxillare (lat)	Most lateral point on the palate-maxillary suture	(2)	P
Petrosal	Most anterior point of the petrous element of the temporal bone	(5)*	C
Porion	Most superior point on the margin of the external auditory meatus	(1)	V
Radiculare	Point of maximum inflection of the zygomatic processes	(1)	V, Z
Sphenion	Most anterior extent of the sphenoparietal suture	(1)	V
Sphenobasion (lat)	Most lateral, inferior point on the sphenoccipital synchondrosis	(2)	C
Sphenomaxillare (sup)	Most superior, lateral point of contact between the maxilla and the lateral pterygoid plate of the sphenoid		V
Sphenosquamosal	Point of intersection of the infratemporal crest and sphenosquamosal suture	(5)	V, Z
Sphenozygomatic (pos)	Most posterior, inferior point on the sphenozygomatic suture		V, Z
Squamous (inf TL)	Point of intersection of the squamous suture and the inferior temporal line		TL
Squamous (sup TL)	Point of intersection of the squamous suture and the superior temporal line		TL
Stenion	Most medial point on the sphenosquamosal sutures	(1)	V, Z
Stephanion	Point where the coronal suture crosses the (inferior) temporal line	(1)	V
Styloid foramen	Most anterior, inferior point on the styloid foramen		C
Temporal fossa (ant)	Most anterior, inferior point on the temporal fossa	(2)	Z
Temporal fossa (lat)	Most lateral, inferior point on the temporal fossa	(2)*	Z
Temporal fossa (pos)	Most posterior, inferior point on the temporal fossa	(2)	Z
Zygion	Most lateral point on the surface of the zygomatic arch	(1)	Z
Zygomaxillare	Most inferior, anterior point on the zygomaticomaxillary suture	(1)	Z
Zygoorbitale	Point where the zygomaticomaxillary suture intersects with the inferior orbital margin	(3)	Z
Zygomatic tuberosity	Most lateral, anteriorly projecting point on the zygomatic bone	(2)	Z
Zygotemporale (inf)	Most inferior point on the zygomaticotemporal suture	(3)*	V, Z
Zygotemporale (sup)	Most superior point on the zygomaticotemporal suture		V, Z

ant, anterior; C, chondrocranium; FH, Frankfurt horizon; inf, inferior; lat, lateral; med, medial; P, palatomaxilla; pos, posterior; sup, superior; TL, temporal lines; V, vault; Z, zygotemporal.

*Adapted from original source.

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Table S3. Climatic variables used to construct climatic distance matrices for 11 populations*

	miTemp	mxTemp	mnTemp	miPrecip	mxPrecip	mnPrecip	miVP	mxVP	mnVP	miCloud	mxCloud	mnCloud
Alaskan	-27.20	5.70	-11.67	0.08	0.85	0.29	0.41	8.30	3.21	55.50	82.60	71.28
Australian	17.10	31.70	25.61	0.02	3.00	0.87	8.00	20.50	13.43	18.20	53.60	33.58
Chinese	1.10	27.50	14.88	0.40	6.50	2.23	4.20	29.40	14.13	43.20	69.80	57.29
Greenland	-21.80	2.30	-10.61	0.50	1.30	0.88	0.80	5.90	2.67	53.10	70.70	63.49
Hawikuh	0.80	21.60	10.78	0.30	2.30	0.92	3.40	12.80	6.19	31.30	49.40	42.67
Ibo	25.00	29.70	26.93	0.04	7.70	3.64	14.70	27.50	23.33	51.50	88.30	68.70
Italian	-3.60	14.00	5.21	2.96	4.52	3.61	3.99	13.09	8.09	51.10	65.20	59.07
Japanese	-1.10	24.50	10.98	2.67	5.68	4.07	4.42	23.40	11.40	66.90	80.60	73.21
Mongolian	-20.50	20.50	1.24	0.00	1.83	0.49	0.99	13.72	5.40	24.70	40.40	32.25
Central African	24.10	27.60	25.40	0.11	7.85	3.72	15.70	25.40	22.36	26.60	65.00	44.08
San	16.10	26.20	22.48	0.00	4.40	1.40	11.30	24.60	17.79	22.40	64.30	43.78

Cloud, cloud cover (%); mi, minimum; mn, mean; mx, maximum; Precip, precipitation (mm/d); Temp, temperature (°C); VP, vapor pressure (hPa).
*Data from New et al. (1, 2).

1. New M, Hulme M, Jones P (1999) Representing twentieth-century space-time climate variability. Part I: Development of a 1961-90 mean monthly terrestrial climatology. *J Clim* 12: 829–856.
2. New M, Lister D, Hulme M, Makin I (2002) A high-resolution data set of surface climate over global land areas. *Clim Res* 21:1–25.

Table S4. Number of landmarks used to quantify the shape of each morphological unit, plus numbers of PC scores used to generate population D-matrices

Morphological units	No. landmarks	No. PC scores
Entire cranium	151	123
Vault	51	47
Chondrocranium	39	61
Palatomaxilla	21	36
Zygotemporal	22	37
Temporal lines	25	15
Mandible	33	42