A Late Pleistocene woman from Tham Lod, Thailand: the influence of today on a face from the past

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Creating a facial appearance for individuals from the distant past is often highly problematic, even when verified methods are used. This is especially so in the case of non-European individuals, since the reference populations used to estimate the face tend to be heavily biased towards the average facial variation of recent people of European descent. To evaluate the problem, a facial approximation of a young woman (25–35 years old) from the Late Pleistocene rockshelter of Tham Lod in Northern Thailand was compared against the average facial variation of datasets from recent populations. The analysis indicated that the Tham Lod facial approximation -was neither overtly recent in facial morphology, nor overtly European. The case is of particular interest since the Tham Lod individual -is likely to have belonged to a population ancestral to extant Australo-Melanesian peoples.

Keywords: Thailand, Late Pleistocene, craniofacial morphology, facial approximation

SUPPLEMENTARY MATERIAL

The methods applied in the facial approximation are presented here as discrete elements, but in practice each is highly inter-related. This includes the identification of the facial landmarks and application of the facial Soft Tissue Depths (fSTD), estimation of the facial features (locations and dimensions of the eyes, nose, mouth and ears), application of the underlying anatomical layers, and estimating surface appearance. Although each facial approximation undertaken differs according to the individual differences displayed by the bones and teeth, more detail regarding the overall approach can be found in prior publications involving forensic, archaeological and palaeoanthropological remains (Hayes *et al.* 2013; Hayes 2014, 2016).

Landmarks and facial Soft Tissue Depths (fSTDs)

The facial landmarks used for this facial approximation are defined in Table S1 below, and are shown, together with the facial Soft Tissue Depths (fSTDs), in Figure 1 in the main text. The fSTDs applied are weighted means calculated by Stephan and Simpson (2008), derived from the more robust fSTD datasets taken from contemporary individuals. Because this facial approximation is accomplished in 2D, only a subset of the available fSTDs have been applied to the right lateral and frontal orthogonal views of the Tham Lod skull reconstruction (14 median landmarks in the lateral view, and 8 landmarks in the frontal view: 3 bilateral and 2 median).

Facial features (eyes, nose, mouth, ears)

For this approach, estimations of each of the facial features refer to published, and mostly verified, averages of skull-soft tissue relationships, many of which are averages of the head, face, feature and craniofacial variation displayed in recent European populations (shown applied in Figure 1 in the main text).

Eyes: The location of the exocanthion has been found to be approximately on the same horizontal plane as the malar tubercle (Whitnall 1911; Stewart 1983; Stephan & Davidson 2008). Because the medial orbital walls were not recovered during excavation, the endocanthion was estimated as being on a horizontal plane approximately 1mm lower than the exocanthion (Stephan & Davidson 2008). Eyeball dimensions are approximately 24mm (Guyomarc'h *et al.* 2012), and are displaced from the orbital centres 1.4 mm superiorly and 2.3mm laterally (Stephan & Davidson 2008; Stephan *et al.* 2009; Guyomarc'h *et al.* 2012). Iris width has been found to have a low level of variation, and is on average 11.65mm (Driessen *et al.* 2011). In the lateral view eyeball protrusion is, on average, 3.7mm anterior to the location of the orbital rims (Stephan 2002a).

Nose: Nasal protrusion, nasal width, nasal wing shape and height, and nasal tip shape was estimated following the algorithms and morphological observations of CT scans of recent populations by Rynn

et al. (2010). These findings, however, have been further modified to correct for the authors' reliance on a mistranslation of Gerasimov's popular science text, *The Face Finder* (1971). This general misunderstanding and misapplication of Gerasimov's 'two tangent method' was first noted by Ullrich and Stephan (2011), and the more accurate reference to the angulation of the aperture base lateral to the anterior nasal spine has recently been verified by a CT scan study (Maltais Lapointe *et al.* 2015). The naso-labial fold follows Gerasimov's unverified observation that it commences at the height of the alar wing and follows an angulation towards the second molar and gonial angle (Gerasimov 1955).

Mouth: Oral fissure width was estimated in reference to the position of the left mental foramen (Song *et al.* 2007; Stephan & Murphy 2008), and checked against the medial border of the left iris, which on average is 1mm anterior to the mouth corner (Stephan 2003). Lip height was calculated using the height of the preserved left lateral upper incisor and lower canine, and referenced algorithms derived from extant individuals of Indian Sub-Continent population affinity (Wilkinson *et al.* 2003). There are unsupported claims in forensic art and facial reconstruction handbooks that lip shape is related to the arc displayed by the alveolar ridge, and that philtrum width corresponds to the distance between the centres of the upper central incisors (Taylor 2001; Wilkinson 2004). The shape of the vermillion was estimated in relation to lip height, mouth corner location, and the shape of the curve of Spee (the arc formed by the occlusal line), while philtrum shape was estimated referencing the central incisor mid-distance. The relationship of lip shape to the curve of Spee is mentioned in orthodontic aesthetic research, which notes (but does not include statistical frequency) a parallel convexity of lower lip shape with the 'smile line' (Ritter *et al.* 2006), and indicates that this convexity reaches stability in adulthood (Kumar & Tamizharasi 2012). The use of the curve of Spee is therefore an unverified relationship. Position of the oral fissure follows the anatomical recommendation of approximately corresponding to the inferior edge of the upper canine (Standring 2008).

Ears: Other than its anatomical location in relation to the external auditory meatus, there is no known correlate between the skull and ear shape, size and protrusion (Guyomarc'h & Stephan 2012). Ear height has, however, been statistically related to the soft tissue distance subnasale-menton for young adults (Farkas & Munro 1987), and this relationship was applied referencing the fSTD derived soft tissue landmarks.

Underlying Anatomy

Warping of each of the virtual muscles and glands followed the deep to surface layers described in relatively recent facial approximations of a prehistoric Amerindian (Hayes 2016), the *Homo floresiensis* holotype (Hayes *et al.* 2013), and is described in more detail within a forensic application (Hayes 2014). Calculation of the maximum depth of the masseter followed the algorithm determined by Kiliaridis *et al*. (2003), which is considered relatively robust by Stephan (2010). This algorithm, however, was derived from 60 individuals aged 7–18 years, and therefore the maximum age (18

years) is somewhat younger than the estimated age of the Tham Lod woman (25–35 years). Muscle attachment patterns were largely indistinct on the Tham Lod remains, and for the most part followed their anatomical locations and descriptions in the more reliable anatomical texts (e.g. Warwick & Williams 1973; Mcminn *et al.* 1999; Standring 2008). Estimation of the inferior temporal line was achieved by referencing the 2000-year-old cranium of a woman excavated from Long Long Rak, which is located near to the Tham Lod Rockshelter, and bears a very similar cranial shape to Tham Lod in the frontal and temporal regions. The completed lateral and frontal view of the underlying anatomy, together with the maximum masseter tissue depth (frontal view), is in indicated in main text Figure 1.

Surface appearance

The final rendering of the surface appearance of the face and features (see main text Figure 2) was largely achieved in reference to historical photographs of Hill Tribe individuals from the Tham Lod region (in particular, Spies 2013), but only those individuals whose photographs display similarity in aspects of size, shape and/or projection to the Tham Lod woman's estimated face and features. There are no currently known relationships between terminal scalp hair and the skull, and therefore indeterminate dark hair was applied keeping to the general shape of the cranial arc, and covering the highly speculative upper ear shape. Eyebrow position follows the general shape of the superior orbital rim, which is an unverified recommendation (Fedosyutkin & Nainys 1993). The location of the eyebrow peak references research undertaken by Stephan (2002b), though Stephan notes that the average eyebrow peak location (2.7mm lateral to the border of the medial iris) has high standard deviations and is therefore not a reliable recommendation.

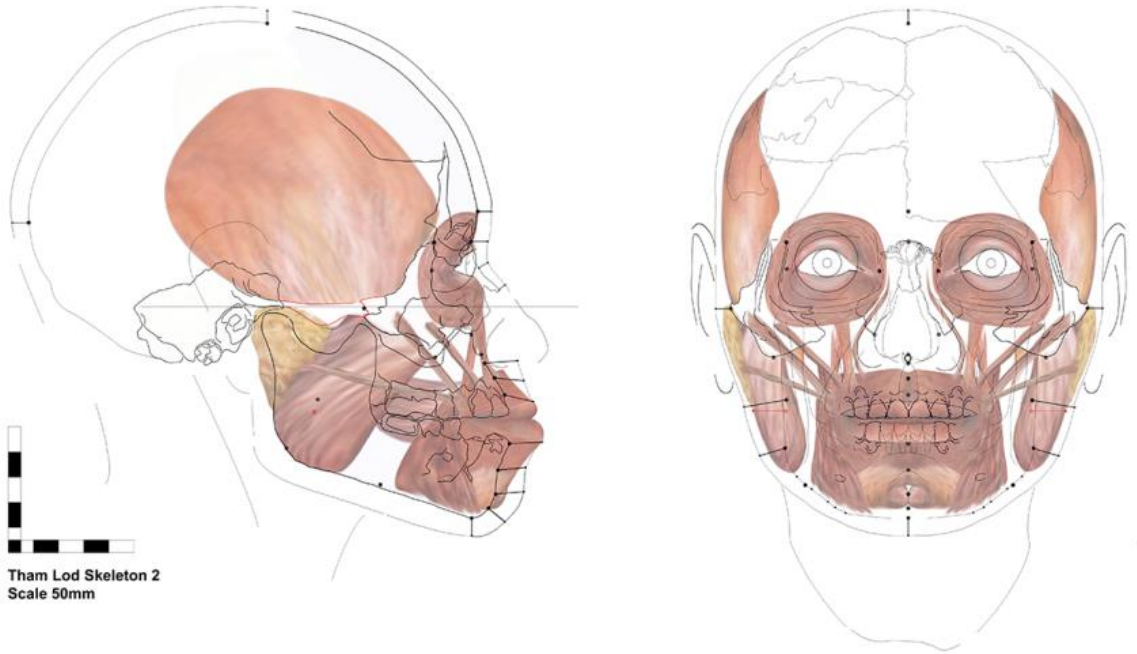

Figure S1. Tham Lod: estimation of underlying anatomical features.

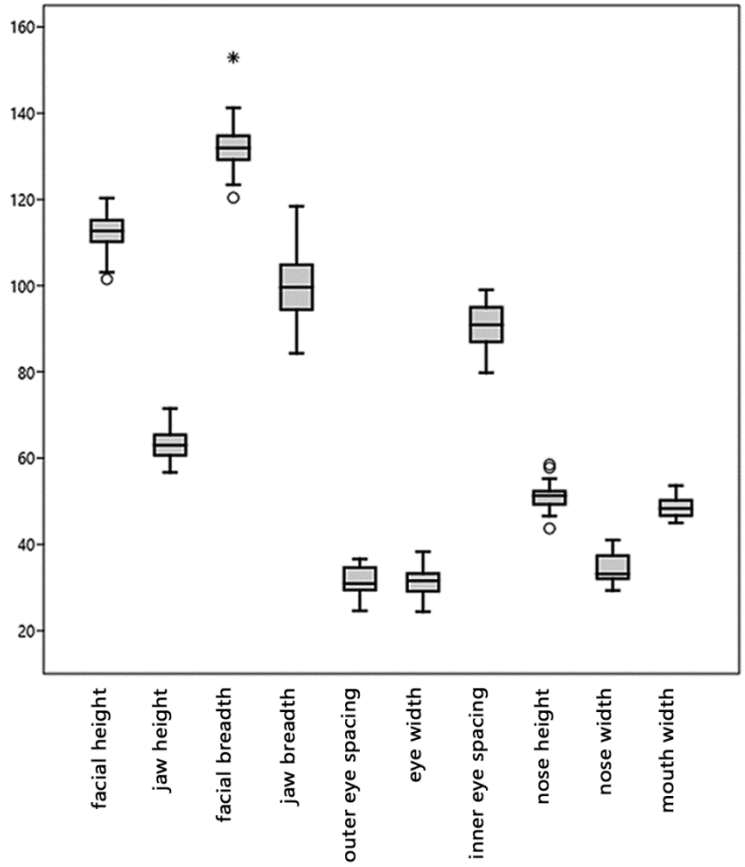

Figure S2. Box plots of the facial measures. Box plot of facial measure variation generated in PAST v.3.08 (Hammer et al. *2001). Open circles are outliers; Tham Lod is the extreme outlier (indicated by an asterisk) for bizygomatic width.*

Table S1. Definitions of the landmarks and facial Soft Tissue Depths (fSTD) applied in the facial approximation. All fSTD and their landmark definitions are from Stephan and Simpson (2008).

Landmark	Landmark definition	Landmark reference	fSTD (mm)
Anterior nasal spine (ANS)	Apex of the anterior nasal spine	(Buikstra & Ubelaker 1994)	n/a
Alare	The widest points of the nasal aperture	(Buikstra & Ubelaker 1994)	n/a
Christa conchalis	Where the inferior nasal concha meets the anterior edge of the nasal aperture wall	(Mcminn *et al.* 1999)	n/a
Endocanthion	Point of insertion of the medial tendon within the lacrimal fossa	(Stephan & Davidson 2008)	n/a
Fronto-zygomatic	The most laterally positioned point on the fronto-zygomatic suture	(Buikstra & Ubelaker 1994)	n/a
Glabella	The most anterior midline point on the frontal bone	(Stephan & Simpson 2008)	5.5mm
Gonion	A point on the mandibular border where a tangent bisects the angle formed by the posterior ramus and inferior corpus borders	(Stephan & Simpson 2008)	10mm
Gnathion	Midline point halfway between the pogonion and menton	(Stephan & Simpson 2008)	8.5mm
Lower lip	Midline point on the maxilla at the most anterior edge of the inferior alveolar ridge	(Stephan & Simpson 2008)	13mm
Malar tubercle	A tubercle situation on the orbital surface of the frontal process of the maxilla, just within the orbital margin	(Whitnall 1911)	n/a
Labiomental	Deepest midline point on the groove superior to the mental eminence	(Stephan & Simpson 2008)	11mm
Menton	The most inferior point of the mandible	(Stephan & Simpson 2008)	7mm
Mid-nasal	Point on the internasal suture midway between the nasion and rhinion	(Stephan & Simpson 2008)	4mm
Mid-mandibular border	Point on inferior border of mandible, midway between pogonion and gonion	(Stephan & Simpson 2008)	n/a
Mid-philtrum	Midline point on the anterior edge of the maxillae, halfway between the base of the subnasale and prosthion	(Stephan & Simpson 2008)	11.5mm
Mid-ramus	A point at the centre of the mandibular ramus	Stephan & Simpson 2008	17.5mm

Nasion	Midline point on the naso-frontal suture	(Stephan & Simpson 2008)	6.5mm
Opisthocranion	Midline ectocranial point at the farthest chord length from the glabella	(Stephan & Simpson 2008)	6.5mm
Pogonion	Most anterior midline point on the mental eminence of the mandible	(Stephan & Simpson 2008)	11.5mm
Prosthion	Midline point on the maxillae at the most anterior edge of the superior alveolar ridge	(Stephan & Simpson 2008)	11.5mm
Rhinion	Midline point at the inferior free end of the internasal suture	(Stephan & Simpson 2008)	3mm
Subnasale	Just below the anterior nasal spine on the midline	(Stephan & Simpson 2008)	13mm
Vertex	The highest midline point on the ectocranium	(Stephan & Simpson 2008)	5mm
Zygion	Most lateral point on the zygomatic arch	(Stephan & Simpson 2008)	6mm
Zygo-maxillary	Most inferior point on the zygomatico-maxillary suture	(White & Folkens 2000)	n/a

Table S2. Facial measurements of Tham Lod and recent women populations (mean: n=30). The recent population data are taken from Farkas *et al*. (2005) and are the means of 30 women (18–30 years) per population group listed (N 720 = 30 × 25). Measures and landmarks: facial height (nasion-menton), jaw height (subnasale-menton), facial breadth (bizygomatic breadth), jaw breadth (bigonial breadth), outer eye spacing (bi-endocanthal breadth), eye width (left endocanthion-exocanthion); nose height (nasion-subnasale), nose width (inter-ala breadth), mouth width (cheilion-cheilion).

	Facial Height	Jaw Height	Facial Breadth	Jaw Breadth	Outer Eye Spacing	Eye Width	Inner Eye Spacing	Nose Height	Nose Width	Mouth Width
Tham Lod	116.1	68.9	152.9	118.4	35.6	26.9	89.3	47.2	41.5	51.6
African American	116.5	71.5	130.5	96.7	34.4	32.2	92.9	48.8	40.1	53.6
Angolan	106.5	63.2	132.8	90.3	36.6	27.1	87	46.6	40.8	52.9
Azerbaijan	111.5	63.6	138.7	102.9	30.5	33.8	94.2	52.3	33.8	49.7
Bulgarian	111	61.6	130.9	98.7	29.7	30.4	91.9	52.1	33	46.2
Croatian	110.4	60.7	133.2	94.6	29.7	38.3	86.3	50	32.9	46.9
Czech Rep.	112.6	66	126.4	107.1	29.1	28.2	80.3	52.1	33.8	50.2
Egyptian	103.1	57.8	130.3	91.2	30.9	30.8	86.3	47.4	29.3	46.7
German	109.5	63.3	123.4	91.5	28.6	31.8	86.4	51.4	31	48.2
Greek	116.4	63.3	132.2	99.2	29.5	32	87.8	52.8	32.4	50.3
Hungarian	112.4	56.7	131.3	95	31.2	34.9	97.3	52.5	33.5	51.6
Indian Sub-Continent	101.5	57.2	124.9	97.4	30.9	31.3	97.5	43.7	33.8	46.5

Iranian	120.3	66.2	131.7	102.7	24.6	24.4	79.8	58.5	32.1	45
Italian	113.8	64.4	133.3	104.9	27.6	32.7	89.5	52.1	29.5	47.7
Japanese	113.8	62.8	141.2	115.6	35	29.2	93.3	53.3	37.1	46.5
Polish	111.6	60.5	135.5	93.9	29.2	32.8	87.4	51.2	32.6	49
Portuguese	118.2	62.8	120.4	84.3	29.1	35.9	93.9	57.8	31.9	45.3
Russian	114.2	61.4	132.3	98.6	32.7	34.5	94.6	50.4	33.2	48.1
Singaporean Chinese	114.9	66.4	136.2	102.3	36.1	28.4	87.3	51.7	37.2	47.3
Slovakian	109.3	58.6	125	105.4	30.7	32.3	96.1	49.4	30.6	48.9
Slovenian	108.8	61.4	129.5	100.7	30.2	33.2	96.1	52	33.1	49.2
Thai	112.8	62.6	138.3	106	36	28.9	99	49.5	40.2	45.4
Turkish	116.4	59.1	134.5	100	31.7	29.8	93.2	55.2	32.9	47.6
Vietnamese	113.1	64	134.3	104.8	36.6	29.2	89.9	50.4	39.8	48.5
White North American	111.8	65.5	129.9	91.1	31.6	30.7	86.8	48.9	31.4	49.8
Zulu	113.7	65.4	128.4	102	34.5	33.4	96.9	49.5	38	52.2

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