Proportions and Angles in the Aesthetic Appraisal of Faces by Expert and Lay Panels

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Abstract

Background: The ability to quantify the aesthetic appearance of a face and the therapeutic improvements made by some medical and surgical techniques could greatly help the objective assessment of care provision.

Aim and Objectives: This study set out to analyse biometric characteristics likely to influence facial aesthetic appraisal.

Method: This was a descriptive cross-sectional study on a group of young adults from Abidjan, Republic of Côte d'Ivoire. For each subject selected, two standardised photographs (full-face and profile) were taken, and expert and lay panels were asked to appraise them aesthetically. After collecting the appraisal scores, photogrammetric measurements were made on paper using a graduated ruler and protractor. The data collected were analysed using the statistical software SPSS 20.0 for Windows. An ANOVA followed by a Tukey HSD test was used to compare the appraisals on the basis of photogrammetric variables. The statistical significance threshold was set at $p < 0.05$. PCA was used to characterise the subjects of the different appraisals.

Results: The subjects deemed attractive had a large lower face with a turned-up nose ($p < 0.01$). Those deemed unattractive had larger noses and more facial asymmetry, with $p < 0.04$ and $p < 0.0001$. There was a gender effect, the mentocervical and interlabial angles being less marked in the females deemed attractive than in the males deemed attractive, with respectively $p < 0.04$ and $p < 0.02$.

Conclusion: Despite the subjective nature of attractiveness, perceived facial aesthetics of Black Ivorians depended on balanced features and facial proportions.

Key words: Face aesthetics – Photogrammetry – Social judgement

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Introduction

In human societies, the aesthetics of the face is an important factor in social behaviour[1]. Aesthetic judgement is a subjective appraisal of a person's physical appearance and attractiveness[2]. It is considered to influence self-perception and self-esteem, and how an individual is perceived and accepted in society [3]. It varies according to ethnic, cultural, civilisational, environmental and psychological factors [1]. Aesthetic judgement is thus qualitative and subjective. To lend it greater objectivity, aesthetic characteristics of faces can be studied using morphometry [4], a field of biometry that quantifies shapes on the basis of measurements using a statistical approach.

In recent years, several studies on the analysis of ideal facial proportions and facial symmetry have identified various aspects of facial attractiveness. Several anthropometric features have thus been associated with attractiveness. Most of these have been especially studied in human faces, because the face is the most important part of the body in social interactions, and facial features are important determinants for overall attractiveness. Some facial features have been associated with attractiveness such as (i) asymmetry, or divergence from bilateral symmetry assigned to an individual, not to a population, (i) average face, or how similar a face is to the population average, (ii) femininity of a face, which refers to those features that identify a person as female, and (iv) youthfulness, or how young a face appears. It has been suggested that these characteristics are linked to attractiveness because they signal assets desirable in a potential mate [5].

In this perspective, cranio-facial characteristics have been evaluated by various methods using cephalometry. Ousehal et al. [1] seeking a link between Steiner's aesthetic norms and beauty in a Moroccan population, had facial beauty appraised by two panels, one expert, and one made up of members of the general public. In view of the variability in the appraisals made according to the panel, they emphasised the need to take into account the socio-occupational categories of the panel members in their aesthetic appraisal. Czarnecki et al.[6] evaluated the perception of face balance using digital imaging.

They concluded that men preferred straight profiles while women preferred a slightly convex profile. Irrespective of gender, protruding lips were deemed more attractive when associated with a protruding chin.

Face analysis based on photogrammetry has also been largely used to assess face structures. Its cost is low and it involves no exposure to radiation, unlike X-ray cephalometry[7-9]. Photogrammetry of facial soft tissues is a method of measurement that allows the objective quantification of dimensional parameters such as proportions and angles of a face by means of photography [10,11]. Merrifield [11] reports the measurement of the Z angle in photographs of profiles to make a rational, precise description of the relation between the lower face and the middle and upper faces. Kim et al. [12], who compared the pre-selected candidates for a beauty contest (Miss Korea) with a general sample from the same population, isolated the nose and eyes as determinants of facial beauty.

Fortes et al. [3] analysed the characteristics of aesthetically pleasing and unpleasing faces in a Brazilian population. They emphasised balance among different facial features as a determinant of facial beauty; this balance showed a marked gender dimorphism.

Despite the diversity of studies on facial aesthetics, no photogrammetric study has sought to determine whether angle measurements on face profiles and facial proportions can predict attractiveness in Black Ivorians.

The aim of this study was to analyse correlations between photogrammetric measurements of face profile angles and face proportions and aesthetic appraisal of faces among Black Ivorians.

Materials and Methods

This was a cross-sectional study of 57 Black Ivorian subjects (29 female, 28 male). It was conducted with the approval and consent of all the participants. The subjects were aged 18–25 years (mean 20.5 years), and all had normal dental occlusion (Angle Class I).

To be included in the study, the subjects had to be natives of the Republic of Côte d'Ivoire, be free from any pathological disorders of the craniofacial soft tissues (bruising, ulceration, etc.), and have no severe craniofacial abnormalities. Subjects who had severe craniofacial antecedents or trauma, or who had undergone orthodontic or prosthetic treatment, or orthognathic or other plastic surgery, were not included in the study.

Two standardised photographs, one full-face and one profile, were taken of each subject selected according to the above inclusion criteria. All the photographs were taken with the same digital camera (Kodak Easyshare C1013) with a 10.3 Mpixel image resolution, mounted on a tripod, the height of which was adjusted so that the optical lens axis was always horizontal and the image sensor plane vertical. The height of the tripod was therefore adjusted to that of each subject for each photograph.

On the wall in front of each subject hung a rectangular mirror measuring 100 × 50 cm fixed 40 cm from a horizontal line marked on the ground. The subject stood straight, feet together straddling the line, 20 cm from the camera.

The photographic method described by Ferrario et al. [13] was used: when the photograph was being taken, subjects were to look straight ahead at the reflection of their pupils in the mirror in front of them (eyes levelled horizontal, and midline of face truly vertical). The subjects were asked to relax, lips in resting position and hands hanging freely on each side of their body. The photographs were thus taken with the head in a natural posture.

Blurred photographs and any with shadow images and/or contractions of facial muscles (e.g. creased or flattened chin pad) were discarded. All the subjects gave their consent after being informed of the study objectives.

The images obtained were randomised and projected onto a large screen for aesthetic appraisal by specially chosen panels.

The panels comprised 40 members in all, in four groups. An expert panel comprised four students from a School of Fine Arts (two female, two male), two teachers from the same School (one sculptor and one graphic artist) two orthodontists (one female, one male), two dentistry students (one female, one male), one female hairdresser-beautician, and one male physical anthropologist, making 10 members in all. Three other lay panels were made up of five laypersons with diversified ages and socioeconomic and cultural backgrounds, of each gender, making 30 persons in all.

The panels (lay and expert) gathered in a comfortable room where they were shown all the images of the subjects in our study on a screen, in black and white (to avoid any influence of skin colour on appraisal). For the aesthetic appraisal, each panel was asked to fill out an appraisal form for each subject. At the top of this form were shown five fields corresponding to different degrees of attractiveness: not at all attractive (2/10), not very attractive

(4/10), moderately attractive (6/10), attractive (8/10), and very attractive (10/10). In the event, no subject scored 10/10, and "not at all attractive" and "not very attractive" were pooled as "unattractive", so that the subjects were conveniently grouped into three categories: attractive, moderately attractive and unattractive.

The results of this first phase were entered into an Excel spreadsheet, and the arithmetic means of the aesthetic appraisals were calculated for each subject and for the whole sample. The mean scores given by the four panels and by the two genders (female and male panel members) were calculated. The digitised images were printed on white sheets using one printer (HP Deskjet 3050). Landmarks and lines were then drawn by hand on these printouts by one operator using a graduated ruler and a protractor on the full-face and profile views. The landmarks are shown in Figure 1.

Trichion (Tr): midpoint of the forehead where it meets the hairline

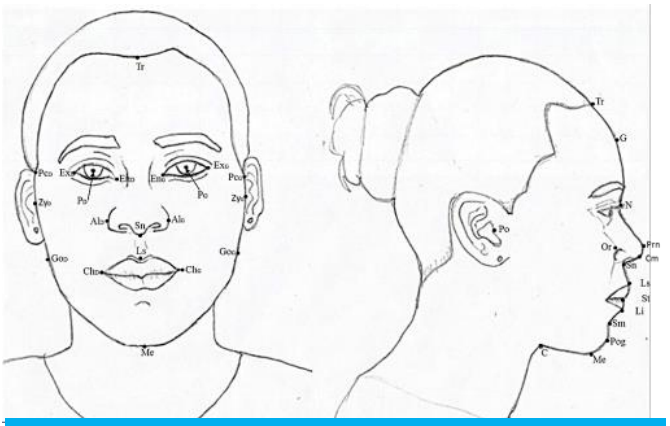


Figure 1: Landmarks Used for Profile Photogrammetry

Glabelle (G): most anterior midpoint of the forehead

Nasion (N): concavity in the midline at the root of the nose

Pronasale (Prn): tip of the nose

Columella (Cm): lowest point under the nose

Subnasale (Sn): point where the upper lip meets the columella

Labrale superius (Ls): point indicating the midline cutaneo-mucous border of the upper lip

Stomion (St): point where the closed lips meet

Labrale inferius (Li) point indicating the midline cutaneo-mucous border of the lower lip

Supramentale (Sm): deepest point of the sublabial sulcus

Pogonion (Pog) tip of the chin

Menton (Me): lowest point of the lower edge of the chin

Cervical ©: point where the neck meets the underside of the chin

Porion (Po): outermost point of the external auditory meatus

Suborbitale (Or): palpable outer edge of the orbit

Endocanthion (En); inner corners of closed eyelids

Exocanthion (Ex): outer corners of closed eyelids

Zygion (Zy): most lateral points of the face, i.e. outermost points of the outside contours of the zygomatic arches

Gonion (Go): lateral meeting points of ramus and corpus between the rearmost point of the mandibular plane (Me-tang mdblr) and the lowest point of the ramal plane (tang ramus).

Cheilion (Ch): corners of the mouth

Pupillary (P): centre of pupils

Construction points (Pc): points marking the outermost contours of the face at bipupillary height

Alae (Al): most lateral points of the nose.

These landmarks were used to determine 13 profile angle measurements and 27 full-face proportions.

(1) Nasofrontal (G-N-Prn): angle between the tangents to the nose and glabelle;

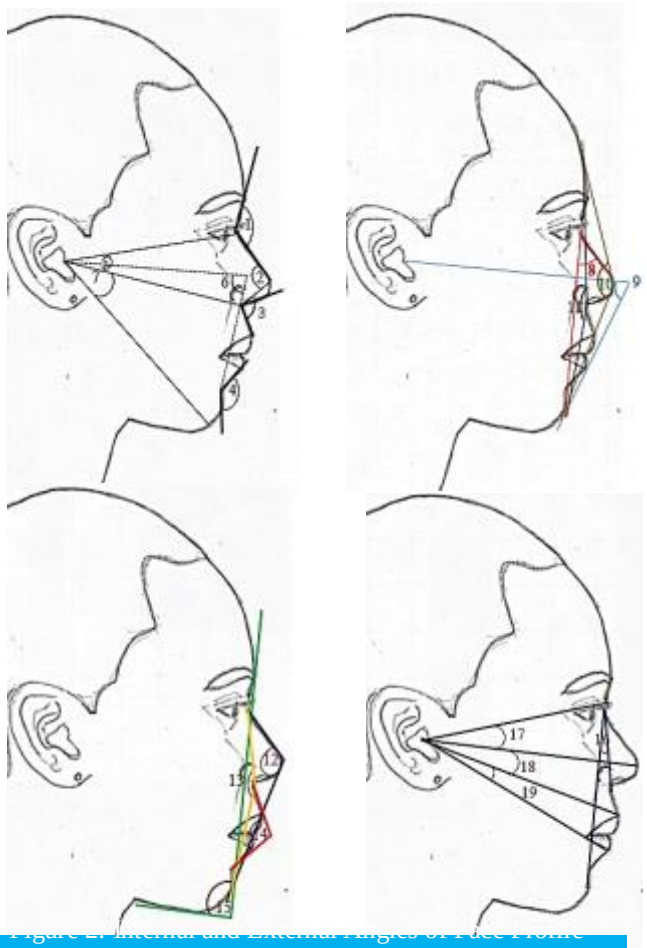


Figure 2: Internal and External Angles of Face Profile

(2) Pronasale (N-Prn-Sn): angle made by nasion, pronasale and subnasale;
(3) Nasolabial (Cm-Sn-Ls): angle made by columella, subnasale and labrale superius;
(4) Mentolabial (Li-Sm-Pog): angle made by labrale inferius, supramentale and pogonion;
(5) Median of facial third (N.Po.Sn): angle made by nasion, porion and subnasale;
(6) Head posture: angle between a line joining the porion (Po) and the suborbitale, and a line joining the supramentale (Sm) and subnasale (Sn);
(7) Lower third of the face (Sn-Trg-Me): angle made by subnasale (sn), porion (Po) and menton (Me).
(8) Nasomental: angle between a line joining the nasion (N) and the pronasale, and a line joining the nasion (N) and the pogonion (Pog);
(9) Z (Po-Or/Pog-Li): angle between the horizontal Frankfurt plane (Po-Or) and a tangent to the menton (Me) and more prominent lip (L);
(10) Face (G-Prn-Pog): angle made by the glabella (G), pronasale (Prn) and pogonion (Pog);
(11) Facial convexity excluding the nose (G-Sn-Pog): angle between the glabella, subnasale and pogonion points;
(12) Overall soft tissue (N-Prn-Pog): angle made by pogonion, pronasale and nasion;
(13) Convexity (N-Sn-Pog): angle made by nasion, subnasale and pogonion;
(14) Mentocervical (G-Pog/C-Me): angle between a vertical line joining the glabelle and the pogonion, and a horizontal line joining the menton and cervical;
(15) Interlabial (Sn- Ls/Li- Sm): angle between a line joining the subnasale and the labrale superius, and a line from the lower fold and tangential to the lower lip;
(16) Sn-N-Pog: angle made by the subnasale (Sn), nasion (N) and pogonion (Pog);
(17) N-Po-Prn: angle made by the nasion (Na), porion (Po) and pronasale (Prn);
(18) Prn-Po-Ls: angle made by the pronasale (Prn), porion (Po) and labrale superius (Ls)
(1) Trichion-nasion/nasion-stomion (Tr-N/N-St);

Figure 3: Full-face Aesthetic Proportions

(2) Trichion-nasion/subnasion-gnathion (Tr-N/Sn-Gn);
(3) Nasion-stomion/nasion-gnathion (N-St/N-Gn);
(4) Trichion-subnasion/nasion-gnathion (Tr-Sn/N-Gn);
(5) Trichion-subnasion/subnasion-gnathion (Tr-Sn/Sn-Gn);
(6) Subnasion-stomion/subnasion-gnathion (Sn-St/Sn-Gn);
(7) Stomion-gnathion/subnasale-gnathion (St-Gn/Sn-Gn);
(8) Subnasion-stomion/stomion-gnathion (Sn-St/St-Gn);
(9) Labrale superius-stomion/subnasion-stomion (Ls-St/Sn-St);
(10) Labrale superius/labrale inferius (Ls-St/St-Li);
(11) Endocanthal distance/face width at bipupillar height (En.R-En.L/Pc.R-Pc.1L);
(12) Endocanthal distance/exocanthal distance (En.R-En.L/Ex.R-Ex.L);
(13) Open right eye width/endocanthal distance (Ex.R-En.R/En.R–En.L);
(14) Open left eye width/endocanthal distance (Ex.L-En.L/En.R–En.L);
(15) Endocanthal distance/nose breadth (En.R-En.L/Al.R-Al.L);
(16) Bipupillar distance/exocanthal distance (P.R-P.L/Ex.R-Ex.L);
(17) Nose breadth/mouth width (Al.R-Al.L/Ch.R-Ch.L);
(18) Mouth width/exocanthal distance (Ch.R-Ch.L/Ex.R-Ex.L);
(19) Mouth width/bipupillar face width (Ch.R-Ch.L/Pc.R-Pc.L);
(20) Nose breadth/nose height (Al.R-Al.L/Sn-N);
(21) Subnasion-stomion/mouth width (Sn-St/Ch.R-Ch.L);
(22) Subnasion-gnathion/mouth width (Sn-

Table I. Method Error Calculation Using Dahlberg's Formula

Variable (mm)	Methoderror
Tr-N	0.31
N-St	0.42
Sn-Gn	0.31
N-Gn	0.94
Tr-Sn	0.79
Sn-St	0.63
St-Gn	0.94
Ls-St	0.10
St-Li	0.79
En.R-En.L	0.63
Pc.R-Pc.L	0.94
Ex.R-Ex.L	0.63
En.R-En.L	0.05
Al.R-Al.L	0.94
Ch.R-Ch.L	0.33
Sn-N	0.72
Tr-Me	0.61

Variable (°)	Methoderror
N-Prn-Sn	1
N- Prn- Pog	0.75
N-Sn-Pog	0.52
Cm-Sn- Ls	1.5
Li-Sm - pog	0.41
Angle Z	0.58
G-N-Prn	0.8
G-Prn-pog	0.1
G-Sn-Pog	0.48
N-prn/N-pog	0.5
G-pog/C-Me	0.32
N-Po-Sn	0.21
Sn-Po-Me	0.8
Po-Ort/Sn-Sm	0.9
Sn-Ls/Li-Sm	0.12
Ls-Po-Li	0.5
Prn-Po-Li	1.5
A-N-B	0.6
N-Po-Prn	0.21

Gn/Ch.R-Ch.L);
(23) bipupillar face width/physiognomic face height (Pc.R-Pc.L/Tr-Me);
(24) Subnasion-stomion/bipupillar face width (Sn-St/P.R-P.L);
(25) Subnasion-gnathion/bipupillar face width (Sn-Gn/P.R-P.L);
(26) Nasion-stomion/bipupillar face width (N-St/Pc.R-Pc.L);
(27) Nasion-gnathion/bipupillar face width (N-Gn/Pc.R-Pc.L).

The data collected were analysed using the statistical software IBM SPSS 20.0 for Windows. The quantitative variables had a normal distribution as shown by their means and a Levenne test. A univariate ANOVA was carried out to compare the photogrammetric variables according to appraisal category and gender. The significance threshold was set at $p < 0.05$. When the null hypothesis was rejected, i.e. the parameters for which the subjects were different, a Tukey HSD test was performed to determine the level of differentiation between subjects. PCA was used to characterise the subjects of different appraisals.

Results

In all, 57 Ivorian subjects (28 male, 29 female) aged 18–25 years were included in this study. The aesthetic appraisal found 10 subjects (4 male, 6 female) attractive, 21 (10 male, 11 female) moderately attractive, and 26 (14 males, 12 females) unattractive.

A reproducibility test was carried out on 20 subjects chosen randomly. On these 20 subjects, the same measurements were made again by the same operator two weeks later, and the first and second measurements compared. Method error was calculated using the formula of Dahlberg (14) $ME = \sqrt{\sum d2/2n}$, where d is the difference between the first and second measurements and n is the number of persons chosen randomly (Table I).

Discrepancies were less than 1 mm for linear measurements, and 1.5° at most for angle measurements. Comparisons of measurements made showed no statistically significant differences between variables.

With $p < 0.01$, the unattractive females (b) had a more open G-N-Prn angle than the attractive (ab) and moderately attractive (ab) subjects. This angle was more acute in the unattractive male subjects (a) than in the others.

The mentocervical angle (G-Pog/C-Me), with $p < 0.04$, was larger in the unattractive females (b) than in any of the men (ab) and the moderately attractive females (ab), who had a slightly larger angle than the attractive females (a).

The unattractive males (a) and the moderately attractive males (a) had a more acute Sn-Ls/Li-Sm (interlabial) angle. This angle was more open in the attractive males (c) than in the attractive females (bc) whose angle was slightly greater than in the unattractive females (abc) and the moderately attractive females (abc) with $p < 0.02$.
The attractive subjects (a) generally had a more acute Ls-Po-Li angle than the others.
The Sn-N-Pog angle was acute in attractive subjects (a) and more open in less attractive ones.

The proportion Ls-St/Sn-St was smaller in the attractive subjects (a) than in the others (b), with $p < 0.00001$.
The attractive and moderately attractive subjects (ab) had a smaller Ls-St/St-Li proportion than the unattractive ones (a). However, this proportion was smaller in the unattractive females than in the unattractive males (a), with $p < 0.00001$.
The proportions En.R-En.L/Pc.R-Pc.L and En.R-En.L/Ex.R-Ex.L were smaller in the attractive females (b); moderate in size in the attractive males, and significantly greater in the other subjects (with $p < 0.02$ and $p < 0.01$ respectively).
With $p < 0.0001$, the attractive females and the moderately attractive females (a) had a greater Ex.R-En.R/En.R-En.L proportion. This proportion was of moderate size in the other subjects.
The attractive (ab) and moderately attractive subjects (ab) had Al.R-Al.L/Ch.R-Ch.L significantly less developed than the others (b), with $p < 0.04$.
N-St/Pc.R-Pc.L was large in the atttractive subjects (ab), of moderate size in the moderately attractive females (bc), and small in the unattractive males (a), with $p < 0.0001$.

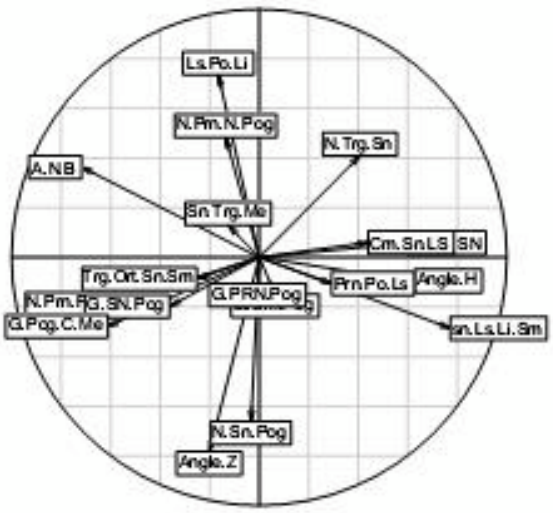
PCA carried out on all the angular variables showed that the attractive subjects were characterised by the angles Sn-Li-Sm and N-Sn-Pog (closely correlated to axis F1). These characteristics were more pronounced in the attractive males. The angle Sn-N-Pog (correlated to the same axis) was greater in the unattractive males. The values of these parameters were low in all the other subjects.

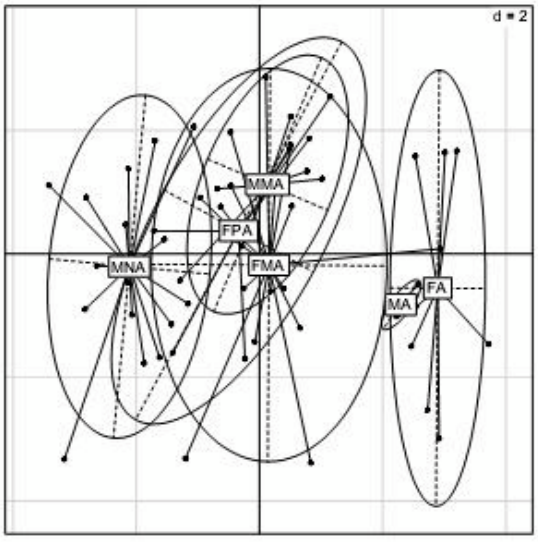
PCA carried out on the basis of linear variables (replaced here by letters) shows the importance of the proportion c (Sn-Gn/P.R-P.L) in the moderately attractive males. The unattractive subjects (FNA and MNA) were characterised by higher proportions x

Table II. Comparison of Angular Measurements on Profil Photographs of Subjects

GENDER	FEMALE *N* = 29			MALE *N* = 28			
Appraisal	Attractive *n* = 06	Moderately attractive *n* = 11	Unattractive *n* = 12	Attractive *n* = 04	Moderately attractive *n* = 10	Unattractive *n* = 14	*p*
Parameter	Mean ± s	Mean ± s	Mean ± s	Mean ± s	Mean ± s	Mean ± s	
N-Prn-Sn	99.5±5.12	96.07±5.69	94.66±7.22	96±1.41	96±8.86	96.56±6.42	NS
N- Prn- Pog	124.87±6.03	124.5±5.43	127±6.29	129.5±0.7	124±4.83	127.06±5.03	NS
N-Sn-Pog	159.12±8.45	161.14±4.55	153±13.74	165.5±6.36	157.57±4.03	158.25±9.91	NS
Cm-Sn- Ls	92.25±9.82	91.14±11.77	90.16±17.73	86±1.41	90.71±13.28	82.88±24.19	NS
Li-Sm - Pog	116.25±9.39	117.28±15.31	114.33±14.97	122.±15.55	119.42±23.75	118.31±7±.16	NS
Angle Z	61.25±8.81	59.78±7.88	58.16±4.21	59±1.41	58±8.83	63±7.53	NS
G-N-Prn	130.87±2.03*ab*	130±6.57 *ab*	136.16±8.97 *b*	134±5.65 *ab*	126±6.13 *ab*	124.5±8.36 *a*	*<0.01**
G-Prn-Pog	146.12±7.84	145.42±6.66	143.16±5.11	144±2.82	145.28±4.78	146.68±4.49	NS
G-Sn-Pog	147.25±6.93	165.85±5.54	164.33±6.08	166±2.82	166.28±3.54	165.81±5.49	NS
N-Prn/N-pog	33.5±3.42	34.92±2.89	34.16±4.66	30.5±2.12	33.14±2.54	33.50±3.72	NS
G-Pog/C-Me	89±1.44*a*	91.71±8.66 *ab*	99.33±7.08 *b*	88±00	93.14±7.35 *ab*	95.25±4.35 *ab*	*<0.04**
N-Po-Sn	26.12±1.24	25.07±2.61	25.33±1.96	26±2.82	26.71±2.13	25.25±2.38	NS
Sn-Po-Me	39.62±2.5	38.28±3.6	47.5±18.55	40±1.32	39.28±2.62	43.31±15.29	NS
Po-Ort/Sn-Sm	90.62±6.54	82.64±19.25	88.16±10.36	87±2.82	89±4.72	89.62±5.21	NS
Sn-Ls/Li-Sm	131.37±9.48 *c*	120.85±9.34 *abc*	119.83±4.62 *abc*	140.5±13.48 *c*	116.85±12.01 *a*	118.81±11.2 *a*	*<0.02**
Ls-Po-Li	7.875±1.4 *a*	11.57± 1.8 2ab	12± 1.54ab	7,75 ±0.95 a	13±1.63 ab	12.62±1.92 ab	*<0.00**
Prn-Po-Li	12.12 1.35	13.14 ±1.83	13.16 ±0.98	12.50±0.57	12.71± 1.79	11.87± 1.40	NS
Sn-N-Pog	8±12 223 *a*	10,83± 2.17 *ab*	11.8± 2.92*ab*	7.2±1.15*a*	11.28 ±1.28 *ab*	12.18± 1.47 *c*	*<0.00**
N-Po-Prn	20.25 2.35	18.85± 3.85	20.50± 1.22	22±00	19.71 ±1.11	19.56±2.22	NS

p < 0.05 significant; p > 0.5 NS (non-significant). Tukey-HSD test for grouping of subjects a, b, ab, abc and c*



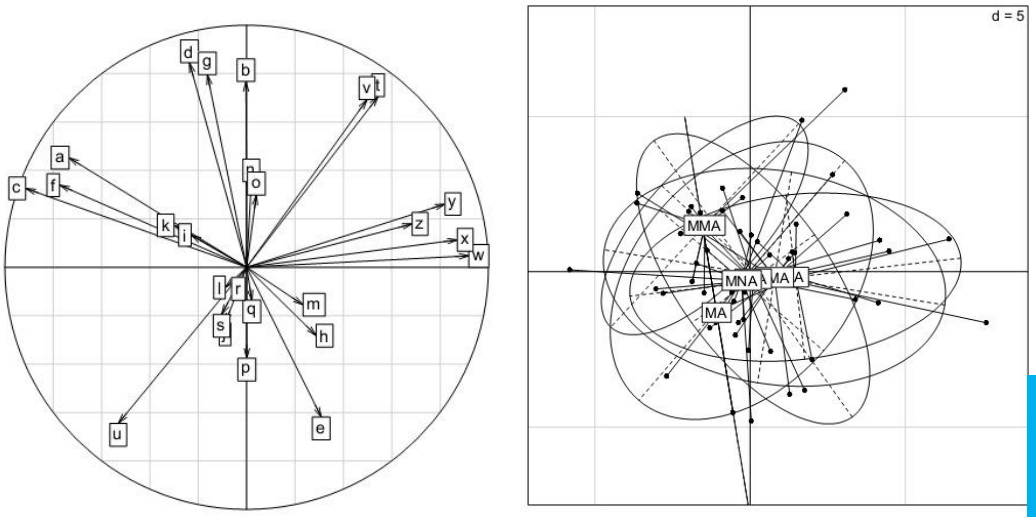


- FA: Attractive females
- FM: Moderately attractive females
- FNA: Unattractive females
- MA: Attractive males
- MM: Moderately attractive males
- MNA: Unattractive males

Figure 4: Characteristics of Subject Appraisals From PCA on the Basis of Angle Measurements

Table III. Comparison of Proportions On Full-face Photographs of Subjects

GENDER	FEMALE (*N* = 29)			MALE (*N* = 28)			
Appraisal	Attractive *n* = 06	Moderately attractive *n* = 11	Unattractive *n* = 12	Attractive *n* = 04	Moderately attractive *n* = 10	Unattractive *n* = 14	*p*
Parameter	Mean ± s	Mean ± s	Mean ± s	Mean ± s	Mean ± s	Mean ± s	
Tr-N/N-St	0.81± 0.3	0.76 ±0.04	0.76 ± 0.05	0.81 ±0.05	0.77± 0.03	0.77± 0.04	NS
Tr-N/Sn-Gn	0.46± 0.02	0.45± 0.03	0.44 ±0.05	0.45 ±0.05	0.4± 0.02	0.44 ±0.03	NS
N-St/N-Gn	0.48± 0.04	0.45±0.05	0.48± 0.04	0.52 ±0.02	0.49± 0.02	0.49 ±0.04	NS
Tr-Sn/N-Gn	0.17 ±0.01	0.16 ±0.02	0.16± 0.01	0.18± 0.03	0.17± 0.01	0.16 ±0.02	NS
Tr-Sn/Sn-Gn	0.75 ±0.02	0.75± 0.03	0.74 ±0.04	0.75 ±0.04	0.73 ±0.02	0.75 ±0.05	NS
Sn-St/Sn-Gn	1.19± 0.16	1.19± 0.14	1.28± 0.15	1.23± 0.11	1.29 ±0.07	1.20± 0.07	NS
St-Gn/Sn-Gn	0.41 ±0.05	0.41 ±0.05	0.44 ±0.06	0.41± 0.08	0.47 ±0.06	0.41 ±0.06	NS
Sn-St/St-Gn	0.40± 0.02	0.42± 0.02	0.40± 0.03	0.41 ±0.02	0.43± 0.03	0.43±0.02	NS
Ls-St/Sn-St	0.42±0.02	0.50 ±0.02	0.58± 0.01	0.40 ±0.002	0.51 ±0.01	0.50 ±0.02	
Ls-St/St- Li	0.52± 0.03 ab	0.52± 0.04 ab	0.58± 0.02 a	0.50± 0.06 ab	0.58± 0.04 ab	0.6 ±0.04 b	<0.00*
En.R-En.L/Pc.R-Pc.L	0.78 ±0.04	0.80 ±0.04	0.80± 0.05	0.80 ±0.04	0.86 ±0.03	0.82 ±0.04	
En.R-En.L/Ex.R-Ex.L	0.68 ±0.02 b	0.70±0.01ab	0.69± 0.00 ab	0.71± 0.01 ab	0.70±0.01 ab	0.71±0.2 a	<0.01*
Ex.R-En.R/En.R–En.L	0.82± 0.09	0.70± 0.07	0.72± 0.10	0.86± 0.02	0.73± 0.04	0.75± 0.08	
Ex.L-En.L/En.R–En.L	0.91± 0.10	0.82± 0.07	0.79± 0.09	0.83 ±0.003	0.83± 0.08	0.85 ±0.13	NS
En.R-En.L/Al.R-Al.L	0.91± 0.10	0.82± 0.07	0.78 ±0.12	0.86 ±0.002	0.84± 0.09	0.86 ±0.13	NS
P.R-P.L/Ex.R-Ex.L	0.36 ±0.02	0.37 ±0.02	0.39 ±0.03	0.37± 0.003	0.37± 0.02	0.36± 0.03	NS
Al.R-Al.L/Ch.R-Ch.L	0.25± 0.02	0.26± 0.02	0.28 ±0.02	0.24± 0.00	0.25± 0.008	0.25 ±0.02	
Ch.R-Ch.L/Ex.R-Ex.L	0.79± 0.08	0.81± 0.10	0.88± 0.16	0.79± 0.00	0.82 ±0.12	0.84± 0.24	NS
Ch.R-Ch.L/Pc.R-Pc.L	0.49± 0.04	0.49± 0.06	0.52± 0.08	0.49 ±0.10	0.47± 0.07	0.49 ±0.11	NS
Al.R-Al.L/Sn-N	0.55± 0.10	0.54 ±0.07	0.53 ±0.03	0.48± 0.07	0.58± 0.13	0.53± 0.10	NS
Sn-St/Ch.R-Ch.L	0.64± 0.04	0.64 ±0.03	0.64± 0.01	0.68± 0.02	0.63± 0.04	0.65 ±0.03	NS
Sn-Gn/P.R-P.L	0.98± 0.14	0.95± 0.13	0.89± 0.08	0.88 ±0.06	0.92± 0.04	0.90 ±0.09	NS
Pc.R-Pc.L/Tr-Me	1.91± 0.23	1.79 ±0.27	1.75± 0.18	1.67 ±0.006	1.62 ±0.17	1.69 ±0.22	NS
Sn-St/P.R-P.L	1.76± 0.08	1.11± 0.09	1.11 ±0.07	1.07 ±0.01	1.04± 0.08	0.07± 0.09	NS
Sn-Gn/P.R-P.L	0.98± 0.14	0.95± 0.13	0.89± 0.08	0.88 ±0.06	0.92± 0.04	0.90 ±0.09	NS
N-St/Pc.R-Pc.L	1.18± 0.17 ab	1.11 ±0.16 bc	0.96 ±0.11 c	1.16± 0.11 ab	1.06± 0.13 abc	0.85± 0.01a	<0.001*
N-Gn/Pc.R-Pc.L	1.31± 0.10	1.24 ±0.10	1.30± 0.17	1.27± 0.11	1.14 ±0.11	1.22 ±0.10	NS



- FA: Attractive females
- FM: Moderately attractive females
- FNA: Unattractive females
- MA: Attractive males
- MM: Moderately attarctive males
- MNA: Unattractive males

Figure 5: Characteristics of Subject Appraisals from PCA on the Basis of Linear Measurements

and w (nose breadth/nose length and open right eye width/intercanthal distance). The other subjects were characterised by moderate values of these variables.

Discussion

The aesthetic appearance of the face is of great importance in today's society [15-17].

The psychological impact of facial aesthetics has a marked influence on quality of life in general. Physical appearance is closely linked to facial characteristics, and affects self-esteem and aesthetic judgements [1]. Our physical appearance has a non-negligible influence on how our beholders judge us. Aesthetic judgement of a face is a subjective appraisal of a person's physical appearance and attractiveness. In clinical practice, this aesthetic appraisal is unfortunately very often left to the practitioner alone, even though aesthetic appreciation varies according to ethnicity, culture, environment and psychological factors [1, 2, 18, 19]. In the present study we collected appraisals made by lay persons in addition to experts.

In clinical practice, practitioners base their aesthetic judgement on both direct perception and photographs, full-face, smiling, three-quarters smiling, or profile. Such photographs have become important routine items in orthodontic files for diagnosis, therapeutic planning and analysis of results. Photographs of this type were mainly used in the present study for photogrammetry and for devising an aesthetic appraisal scoring system.

The use of profile, full-face and three-quarters smiling has been reported in the literature, with its advantages and drawbacks.

Such photographs do not fully reflect the attractiveness of a face because they do not show dynamic characteristics. However, one of their advantages is that they are generally available in clinical files.

Several facial features have been described as reliable indicators of attractiveness, but very few studies have considered the simultaneous influence of several measurements [5].

The beauty and attractiveness of a face are easy to identify, but hard to quantify. Despite its subjectiveness, an attempt can at least be made to define, measure and account for attractiveness in terms of numerical and geometric variables.

The golden number (or golden ratio), also known as the divine proportion, has long been considered by many as holding the mystery of beauty. It is an irrational number, symbol Φ (phi), equal to 1.618033988...[20].

Several studies have found a correlation between attractiveness and proportions in face measurements close to the golden ratio.

The results we describe here are consistent with much of what is reported in the literature.

The average nasofrontal angle (G-N-Prn) in attractive and moderately attractive subjects (ab) reflected a balanced prominence of the nose area in these subjects compared with the others, who had broader noses. However, its openness in unattractive females (a) indicated a retrusive forehead and/or a flatter, broader nose (platyrhinian type), a characteristic among Black Africans. This angle was very acute in unattractive males, emphasising a more marked glabelle in these subjects rather than a turned-up nose. In a Korean sample, Kim et al. [12] used photogrammetry to compare the facial morphology of reference subjects deemed attractive with that of the general population. The nasofrontal angle (G-N-Prn) was 144° ± 8.28 in the reference sample. This value, higher than that observed in our study (130.87° ± 0.3) reflects a more salient glabelle in the Ivorians and a facial retrognathism in the Koreans compared with the Ivorians. Our results are close to those of Anic-Milosevic et al. [8] in Croatian subjects (137° ± 8.2).

The mentocervical angle (G-Pog/C-Me) and lip angle (Ls-Po-Li) were significantly smaller in the attractive subjects (a) (Table II), i.e. the subjects judged attractive had thinner lips and a less salient chin. Chin and lips are both complex and important in the quest for an ideal face [9].

Our results are close to those of Kiekens et al. [10], who found an Ls-Po-Li angle of 7°.

Aesthetic gender dimorphism was seen here in the smaller nasofrontal (G-N-Prn) and interlabial (Sn-Ls/Li-Sm) angles in the attractive females (respectively 130.87° ± 2.03 in the females against 134° ± 5.65 in the males, and 131.37° ± 9.48 against 140.5° ± 13.48) as shown by PCA. Thus the attractive males, unlike the attractive females, had a less marked nasal saddle. In other words, the attractive females differed from the attractive males by having more convex faces. Anic-Milosevic et al. [8] conducted a photographic study of 110 Caucasian Croatian students (52 males, 58 females) aged 23–28 years with normal dental occlusion [21]: the females had a nasofrontal angle (G-N-Prn) of 139.1° ± 6.35 against 136.38° ± 6.7 for the males. These values, higher than those observed in our study, show a more marked nose hollow and longer nose in the Croats and/or a more prominent forehead in Black Ivorians in general (Table II).

Oghenemavwe et al. [21] in their study conducted in Igbo adults in Nigeria, found a similar nasofrontal

angle to those in our study (130.18° ± 8.84 for males and 134.29° ± 9.18 for females). This similarity may be linked to a prominent glabelle in both peoples, rather than a protruding nose in attractive subjects.

The Sn-N-Pog angle (7.5° ± 1.15) of the attractive males (a) was smaller than that of the attractive females (8° ± 1.22). However, the results of the work of Anic-Milosevic et al. (8) showed that the average Sn-N-Pog angle in the Croatians was smaller than that obtained in the Ivorians (Table II). This difference reveals a facial retrognathism in the Croatians (7.08°) [21].

From Ancient Greece to modern times, scientists and mathematicians, artists, architects, and surgeons have been intrigued by the omnipresence of the divine proportion and its link to beauty [20]. Ricketts has claimed that the proportions of a pleasing face are intimately linked to the golden ratio [22-24]. The human face is divided up vertically into three tiers that should be of equal size in a balanced face [22]. However, these three tiers are in fact seldom equal [20]. The results of our study show very little significant difference between the three tiers of the face according to attractiveness. Only two ratios out of ten showed significant differences (R9 and R10). For the horizontal facial proportions, four ratios out of nine showed significant differences (R11, R12, R13 and R17). These ratios do not reflect the whole face, but they involve the dimensions of three features: the nose, eyes and mouth.

The ratios of upper lip thickness to upper lip length (Ls-St/Sn-St) and upper lip to lower lip thickness (Ls-St/St-Li) were smaller in attractive subjects (a) i.e. they had less voluminous lips (as shown above by angle measurements). Moderately attractive males were characterised by a high value of the ratio of upper third to mouth width (Sn-Gn/P.R-P.L). The unattractive subjects were characterised by greater values of the ratios of nose breadth to nose length and open right eye width to intercanthal distance.

These results corroborate those of Farkas et al. [25], who in an American population obtained a value of 0.36 for the ratio of upper lip thickness to lower lip length (Ls-St/Sn-St) and 0.88 for the ratio of upper lip to lower lip thickness (Ls-St/St-Li). However, these values, which are higher than those of Rosseli et al. [26] emphasise the more fleshy lips of Ivorians compared with those of Turks, in whom the ratio of upper lip to lower lip thickness (Ls-St/St-Li) was 0.463 for females and 0.448 for males.

The ratios of endocanthal distance to face width (En.R-En.L/Pc.R-Pc.L) and endocanthal to exocanthal distance (En.R-En.L/ExD-Ex.L) were smaller in the attractive females and significantly high in all the males, i.e. the attractive women had large eyes, often loosely considered a criterion of beauty.

The ratio of open right eye width to endocanthal distance (Ex.R-En.R/En.R-En.L) was greater in the attractive subjects than in the others, i.e. the unattractive and moderately attractive subjects had a larger right half-face than the attractive subjects. This proportion correlated with the ratio of open left eye width to endocanthal distance (Ex.L-En.L/En.R-En.L). This asymmetry was more marked in the subjects whose ratios Ex.R-En.R/En.R-En.L and Ex.L-En.L/En.R-En.L were different from 1 [10], i.e. the unattractive subjects had more asymmetrical faces.

The ratio of nose breadth to mouth width (Al.R-Al.L/Ch.R-Ch.L) was greater in the unattractive subjects than in the others, whereas the ratio of nose length to face width (N-St/Pc.R-Pc.L) was significantly higher in the attractive subjects (graph ACP II and Table III). The unattractive subjects had shorter, broader noses than the attractive subjects, with a length similar to those subjects found moderately attractive: for a face to be found pleasing, the nose, lips and chin must thus be well balanced [3].

Biometric analysis of facial morphology according to aesthetic appraisal revealed some specific biological characteristics. For an objective identification of the aesthetic characteristics of facial morphology, any detailed analysis must take into account ethnicity. For many years, radiography was used for this purpose, but today standardised photography has gained importance in clinical research. This is because of the ease and accuracy with which the soft tissue of the face can be reproduced in fine detail by photogrammetry, and not least because the method costs little and entails no radiation exposure, unlike cephalometry [7].

Faces deemed attractive generally display an overall balance among different measurements, with proportions close to the golden ratio. However, aesthetic criteria have been laid down in almost all cultures, and the existence of truly codifiable facial proportions in attractive subjects is still a matter of debate. Scientific studies of facial attractiveness on the basis of quantitative measurements are thus necessary.

Conclusion

The parameters used in this work helped to identify the aesthetico-biometric facial characteristics of Black persons in general and Black Ivorians in particular. These were characterised by

an imbalance in the upper, mid- and lower face, and a relative facial asymmetry. The imbalance emphasised the lower face, with a more marked asymmetry in persons deemed unattractive. Persons deemed attractive had greater interlabial and nasofrontal angles, but narrower noses, smaller mentocervical angles and thinner lips. Persons deemed moderately attractive resembled those found attractive by their narrow noses and thin lips, but also those found unattractive by their facial convexity.
Further work taking into account photogrammetric, radio-cephalometric and direct anthropometric data on a larger sample will be required to fully identify the biometric characteristics of facial aesthetics.

Contributors

BJ, DM, KAML, KMKK contributed to conceptualization, design, data collection and writeup.

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Self

Conflict of Interest

Nil

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