The Science Behind Nefertiti's Beauty: A Plastic Surgeon's Analysis

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Abstract

Introduction The famous stucco limestone coated "Bust of Nefertiti" housed in the Neues Museum, Germany dated 1,345 BC is an icon of beauty. Sculpted around three millennia ago by Thutmose, the bust still emits a charm that leaves its audience spellbound. However, no one, to the best of author's knowledge, has analyzed this sculpture or its photographs objectively to determine if there is any scientific basis to its attractiveness.

Materials and Methods High-resolution photographs of the bust were anthropometrically analyzed in frontal and right lateral profile views using neoclassical canons and Farkas' studies.

Results The photographs of the bust exhibit many of the neoclassical canons and proportions of Farkas' studies exactly, while many of the remaining are very close to these measurements. A few measurements are out of range of what is considered acceptable these days; however, her overall appearance is pleasing.

Conclusion Despite passage of more than three millennia, the proportions and parameters defining beautiful faces have largely remained unchanged.

Keywords
► beauty
► face
► anthropometry
► calcium carbonate
► sculpture
► esthetics
► reference standards
► plastic surgery

Background

The bust of Queen Nefertiti, the great royal wife of the Pharaoh Akhenaten, is an epitome of the idyllic beauty. Queen Nefertiti, along with King Akhenaten, ruled Egypt from their newly shifted capital city of Amarna where they established a new monotheistic religious order propagating the worship of only the Sun God, also called Aten.[1] This period in the history of Egypt is marked by creation of several architectural marvels. Among these, the bust of Queen Nefertiti is inarguably one of the best. The bust was made by the royal sculptor Thutmose around 1,340 to 1,345 BC, almost 3,500 years ago.[1–3] It was a model sculpture that was used to train other sculptors and to make more sculptures. She was discovered in Amarna on December 6, 1912, by a team led by German archeologist Ludwig Borchardt, financed by the German Oriental Company and aided by the Berlin Museum and the Egyptian archeological authorities.[1] When the spoils of the excavation were divided between the Egyptians and the Germans, Nefertiti came in the share of Germans. It was initially housed as a private collection of one of the sponsors of excavation with a viewing only for a selected, privileged audience. However, it was soon donated to the Berlin Museum and made available for public viewing where its unparalleled beauty started a "frenzy" among its audience. Nefertiti in Egyptian language means "the beautiful one has come." A radiological study was published in 2009 by Alexander Huppertz where the bust underwent a multisection computed tomography (CT) scanning with 0.6-mm thickness cuts and two-dimensional (2D) and three-

dimensional (3D) reconstructions of the core and surface were done.[4] An interesting finding of this study was that the core of the statue reveals that Nefertiti was an aging queen with perioral, periorbital, and cheek wrinkles and a bump over the nose being delicately carved in limestone by Thutmose.[4] However, he later chose to cover the signs of aging and asymmetry with a layer of stucco and the final version of the bust was of a youthful queen that has mesmerized one and all, so much so that she has an esthetic procedure called "Nefertiti lift," named after her.[5–7] There have been several studies describing her beauty[2,3] subjectively, but there has been no objective scientific study, to the best of author's knowledge, that has tried to analyze the basis of her beauty. This paper aims to analyze the proportions of the photographs of the bust in a scientific manner using anthropometry.

Materials and Methods

High-resolution, well-lit, copyright-free, frontal and right lateral profile images of Queen Nefertiti's bust were searched for this study. Out of the hundreds of images of the bust of Nefertiti available on the internet, only the images where the name of the photographer, date of photography along with the camera details and specifications of photographs includ-

Fig. 2 Anthropological points on the bust in lateral profile view (Source: Magnus Manske, CC BY-SA 3.0, via Wikimedia Commons).[23]

ing resolution and place of photography were clearly mentioned were chosen. The photographers have declared their photographs to be original and permitted free of cost usage by general public without modifying them and by giving due credits to the photographers. These images with clear titles and specifications were magnified on the computer screen to that maximum size that did not cause any loss of clarity of important anthropological points. The anthropological points/angles and the significant lines/planes were drawn at this maximal magnification to ensure accuracy (►Figs. 1–4).

Printouts of these images were taken on A4-sized paper and measurements were made by the author and two independent observers using standard ruler and protractor. The mean of these three measurements was rounded off to the nearest whole-digit number and is detailed in ►Tables 1–3. The measurements were utilized to assess the neoclassical canons (►Fig. 5) and Leslie Farkas' proportions[8–10] (►Fig. 6). All the lines that could be correctly assessed have been marked in solid lines. As the queen is wearing a crown, the trichion point could not be clearly assessed. However, for completion of representation, the trichion line was extrapolated from lower two canons and was marked in dashed line in ►Fig. 2 but it was not used in assessing any proportion. Barring the upper third canon, all other standard anthropologic proportions were calculated. These proportions are tabulated in ►Table 4.

Fig. 1 Anthropological points on the bust of Nefertiti in frontal view (Source: Giovanni from Firenze, Italy, CC BY 2.0, via Wikimedia Commons).[22]

Fig. 3 Angles of the face on the bust in lateral profile view (Source: Magnus Manske, CC BY-SA 3.0, via Wikimedia Commons).[23]

Fig. 4 Mentocervical and chin projection angles (Source: Magnus Manske, CC BY-SA 3.0, via Wikimedia Commons).[23]

**Table 1** Anthropological measurements (frontal view) from ►**Fig. 1**

Sl. no.	Name of measurement (frontal)	Measured on A4-sized printout in millimeters (mm)
1	Alar base	18
2	Face width (distance between zygomas at most prominent area of malar region)	72
3	Intercanthal distance	18
4	Right eye length	18
5	Left eye length	18
6	Trichion to nasion (not available as she is wearing a headgear)	–
7	Nasion to subnasale	33
8	Subnasale to gnathion	33
9	Distance between lateral most points of mental tubercles	26
10	Distance between gonion of either side	52
11	Right eyebrow lateral to the vertical through the superior-most point of eyebrow	10
12	Right eyebrow medial to the vertical through the superior most point of eyebrow	18
13	Width of mouth	28
16	Upper lip red vermilion	5
17	Lower lip red vermilion	8
18	Midline to right sternoclavicular joint	11
19	Midline to left sternoclavicular joint	11

Table 2 Anthropological measurements (lateral view) from ►**Fig. 2**

Sl. no.	Name of measurement (lateral)	Measured on A4 sized printout in millimeters
1	Nasion to subnasale	25
2	Subnasale to gnathion	25
3	Ear length	25
4	Nose length	25
5	Upper lip length (subnasale–stomation)	8
6	Lower lip length (stomation–sublabial point)	6
7	Chin (sublabial point to gnathion)	10

Table 3 Nefertiti's photographs' right lateral profile measurements of angles from ►**Figs. 3** and **4**

Sl. no.	Name of measurement	Measurement in degrees	Range of normal in degrees
1	Nasofrontal angle	145	134 ± 7
2	Nasolabial angle	95	95–100
3	Nasofacial angle	30	35–40
4	Chin projection	14	11
5	Mentocervical angle	88	80–95
6	Cervicomental angle	121	105–120
7	Nasal inclination from Frankfurt line	60	–
8	Ear inclination from Frankfurt line	65	–
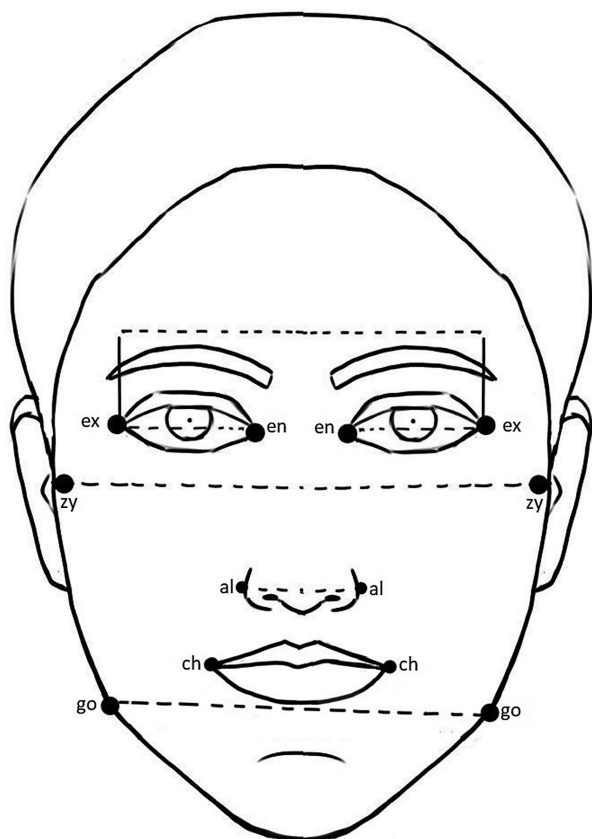
Fig. 5 Frontal view markings for anthropological points in neoclassical canons.
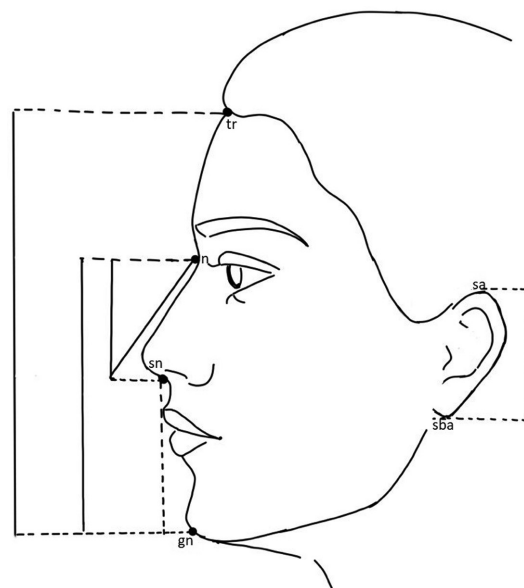
Fig. 6 Lateral view markings for anthropological points in neoclassical canons.

Results

Both in frontal and lateral profile views, the lower two canons of the three canon proportions are equal with a ratio of 1:1. However, as the upper third of facial canons could not be assessed due to headgear, it was left out in calculation of proportions. The nasofacial, orbital, orbitonasal, and

Table 4 Ratio/proportions derived from measurements of ►Tables 1–3

Sl. no.	Proportions	Description	Measurements/ratio and view in which measurement taken
1	Three-section canon	Since the upper part is covered with a crown and trichion could not be measured only lower two of the three canons could be assessed	Ratio of nasion–subnasale to sub-nasale–gnathion: 33/33 mm =1:1 (frontal view) 25/25 mm =1:1 (right lateral profile view)
2	Nasofacial proportion canon	Width of distance between the zygomas to width of ala	72/18 mm = 4:1 (frontal view)
3	Nasoaural proportion	Length of nose to height of ear (right lateral profile view)	25/25 mm = 1:1 (right lateral profile view)
4	Nasoaural inclination proportion	Inclination of nasal dorsum to inclination of ear	65/60 degrees = 1.08:1 (right lateral profile view)
5	Orbital proportion canon	Distance between medial canthi to width of eye fissure	18/18 mm = 1:1 (frontal view)
6	Orbitonasal proportion canon	Distance between medial canthi to width of ala	18/18mm = 1:1 (frontal view)
7	Nasooral proportion canon	Width of mouth to width of ala	28/18 mm = 1.56:1 (frontal view)
	Other proportions		
8	Upper lip to lower lip vermilion in midline		5/8 mm = 1:1.6 (frontal view)
9	Vertical drawn from the highest point of eyebrow passes through the lateral limbus and proportion of eyebrow length on either side of the vertical was measured	Length of eyebrow lateral to vertical vs. medial to vertical	10/18 mm = 1:1.8 (frontal)
10	Ratio of the intergonion width to intermental tubercle width		52/26 mm = 2:1 (frontal)
11	Upper lip to lower lip to chin		8/6/10 mm = 33.3:25:41.7% (right lateral profile view) vs. (Farkas et al) 31.2: 26.2: 42.6%, respectively[10]

nasoaural proportions are 4:1, 1:1, 1:1, and 1:1, respectively (►Table 4). The nasooral proportion is 1.56:1. The upper lip to lower lip vermilion ratio is 1:1.6. Vertical drawn from the highest point of her right eyebrow passes through lateral limbus, dividing the eyebrows in medial, and lateral parts with a ratio of 1.8:1. Her well-defined jawline has an intergonial width to intermental tubercle width ratio of 2:1 (►Table 4). Vertical from the center of her submental area to midline of the sternal notch divides the distance between the two sternoclavicular joints equally in ratio of 1:1.

The line joining the right angle of her mouth to the lateral canthus touches the lateral end of the eyebrow, while the vertical drawn from the medial limbus of her right eye passes through the angle of her mouth (►Fig. 1). As the frontal view has multiple shadows in the lower third of face, the lower third face proportions were calculated from her right lateral view. Her upper lip makes 33.3%, lower lip makes 25%, and chin makes 41.7% of lower third of her face, respectively. These findings are similar to findings of Farkas[10] where the upper lip, lower lip, and chin make 31.2, 26.2, and 42.6% of the lower third of the face, respectively. Her nasoaural inclination proportion is a ratio of 1.08:1 with the angle of inclination of ear and nose from the Frankfurt line being 65

and 60 degrees, respectively (►Fig. 3). Her nasofrontal angle is 145 degrees, which is higher than the angle of 134 ± 7 degrees,[11] considered ideal for women currently. The nasolabial (95 degrees),[11] mentocervical (88 degrees),[12] and cervicomental(121 degrees)[13] angles are within normal range (►Figs. 3, 4). Her chin projection angle is 14 degrees (►Fig. 4).

Discussion

Despite significant ethnic variations in populations across the world, a beautiful face can always be distinguished. Though there are faces that are beautiful even with asymmetries,[14] the most predictable attributes of a beautiful face are symmetry, balance, proportion, harmony, and good skin. The purpose of this anthropological exercise was to analyze if there was any scientific explanation behind the timeless beauty of Nefertiti's bust that makes its beauty relevant even in current times, almost 3,500 years later from the time when she lived. While there have been previous publications that have subjectively described Nefertiti's well-defined cheekbones, nose, and jawline, arched eyebrows; long, slender neck, and full lips as the reason behind her

beauty,[2–5] this is the first attempt in medical literature to analyze her photographs using anthropometry.

Although direct anthropometry is more accurate than photographic anthropometry,[15,16] anthropometry of the photographs of the bust photographs whose authenticity has been declared in public domain was done here. The ideal scenario would have been exact measurements on the bust followed second in accuracy by analysis of photographs directly taken by author. However, that was not feasible as currently no photography of the bust is permitted in the museum due to security reasons. This is a shortcoming of the study. Another limitation of photographic study of images in public domain is that they could have been morphed. However, these two images have been chosen as they were declared to be authentic and not manipulated by Magnus and Giovanni, the photographers of these images.

The validity of neoclassical canons, described and extensively used by Leonardo da Vinci, Albrecht Durer, Piero della Francesca, Johann George Bergmuller, and others four to six centuries ago, has been challenged by many but they still remain important tools in assessing the face of an individual,[11,12] and studies have shown that many of them still hold true.[17] Similarly, the golden proportion φ of approximately 1:1.6, first defined by Euclid of Alexandria, a Greek mathematician around 300 BC and later named so by Ohm has been questioned but continues to be used.[18] Most of the bust photographs' proportions conform to the neoclassical canons (►Table 4). The few measurements that differ from the neoclassical canons and current standards in anthropometry are as follows:

- As per the current ideals the upper and lower lip vermilion ratio of 1:1 to 1:1.5 is considered desirable[19] but the sculpture displays the golden ratio of 1:1.6.
- Her nasooral proportion is 1:1.56 (closer to the golden ratio) in contrast to the 1:1.5[8,11] that exists in the neoclassical canons thereby meaning that Nefertiti's bust has a slightly wider mouth than is considered esthetically pleasing in neoclassical canons.
- Her nose and ear, though equal in size, are not parallel.
- The vertical drawn from the highest point of her right eyebrow passes through lateral limbus, dividing the medial and lateral eyebrow in a ratio of 1.8:1. This is a minor deviation from the currently preferred esthetic ratio of 2:1[11,12] for this parameter, implying her eyebrow's highest point is slightly medial to what is considered beautiful these days.
- She has a relatively flatter and retroclined forehead with a nasofrontal angle of 145 degrees which is higher than the angle of 134 ± 7 degrees, currently considered ideal for women.[11]

Despite these minor deviations and absence of her left eye, variedly attributed to ophthalmic infection by ophthalmologists, uveitis due to Behçet's disease by dermatologists, use of the sculpture as a model for training by some others, and inability to have completed the bust by many others[3]; she remains an epitome of beauty. The most surprising is that while the neoclassical canons have been described only over the past four to six centuries,[17] Thutmose sculpted her very close to these proportions 3,500 years back. After his initial sculpting of Nefertiti in limestone with her wrinkles, hollower eyes, and nose asymmetry[4] intact, Thutmose chose to cover her bust with a thin layer of stucco to even out all the signs of aging and asymmetry,[4] similar to what current day plastic surgeons do using fillers, neurotoxins, and fat grafting. While it would always remain an enigma whether it was Queen Nefertiti who had a perfectly proportionate face or it was the sculptor's almost perfect sense of facial proportions that make her bust beautiful, it can be safely said that the standards that define beauty and the scientific basis of what we subconsciously perceive as beautiful have not changed significantly over the past 3,500 years. While asymmetric faces do not necessarily translate to ugliness, it is observed that every beautiful face has a certain harmony to it. Exercises of analyzing beautiful faces/their photographs can improve a plastic surgeon's perspective and skill for facial esthetic surgery. Surgeons with a flair for such analysis and arts may have an upper hand in delivering more natural and proportionate results.[20,21]

Conclusion

Nefertiti's bust was sculpted more than three millennia ago, while neoclassical canons and studies by Farkas et al demonstrating facial proportions are relatively recent. However, despite the different time frames of these three events, the author's photographic anthropometry objectively shows that most of her anthropometric proportions are very similar to the neoclassical canons and studies by Farkas et al, thereby suggesting that the proportions and parameters defining facial beauty and attractiveness have more or less remained unchanged over time.

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