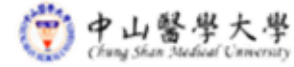Theme: Accelerating the Evolution of the Whole-evidence Approach to Promote Health

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Measure and comparison of facial attractiveness indices through photogrammetry and statistical analysis

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Introduction

Beauty has been defined as a combination of qualities that give pleasure to the senses or to the mind.

Social, cultural and environmental factors influence the perception of beauty. For the face these considerations become even more important, being the key of all social interactions.

Aesthetic criteria have been defined in almost all cultures, but the relationship between the facial dimensions and attractiveness remains unclear.

The face can also provide valuable information that allows to uniquely identify an individual. The morphology, although constantly changing over the course of life, always maintains some basic features that allow for recognition.

Introduction

Evolutionary psychology proposes that there are four main aspect to influence facial attractiveness in the biologically significant assessments of mate value.
These proposed cues are averageness, symmetry, youthfulness and sexual dimorphism.

With the support of data and data processing algorithms and tools, an attempt is made to support visual perceptions in order to seek a measurable characterization of attractiveness.

In this way, what people consider as "attractive" becomes objective.

Purpose of paper

In this study, the faces of 32 participants in an Italian beauty contest in 2015 were analyzed in a non-invasive way.

The linear and angular measurements obtained after processing the images were compared with those collected on a sample of 33 healthy women, of the same age, ethnicity and in the same year, considered as a reference group.

The aim was to demonstrate whether there are statistically significant differences that would allow us to delineate, even quantitatively, the features of a face considered attractive.

Methodology

The study was conducted by comparing the main measures of facial attractiveness between the following two datasets:

- the first one including 32 Italian Caucasian women's face participating in a national beauty contest in 2015 (Miss Italy, 2015), for this reason considered as attractive individuals;

- the second dataset including 33 faces belonging to Italian Caucasian women of the same age group.

All the women had normal teeth and had not suffered craniofacial trauma, which could therefore alter the result obtained. All the women involved gave their informed consent to carry out the experiment.

Methodology

Photogrammetry, compared to other techniques used in orthodontics, is a non-invasive, painless technique and does not use ionizing radiation. The above points, before being acquired by the machine, were identified by direct palpation of the face and marked with a black eyeliner. Then the women sat with a serious expression in front of the 3Draw, Polhemus Inc., Colchester, VT, a system consisting of 5 chambers that outputs the real metric data of the points identified in a time equal to 1 minute.
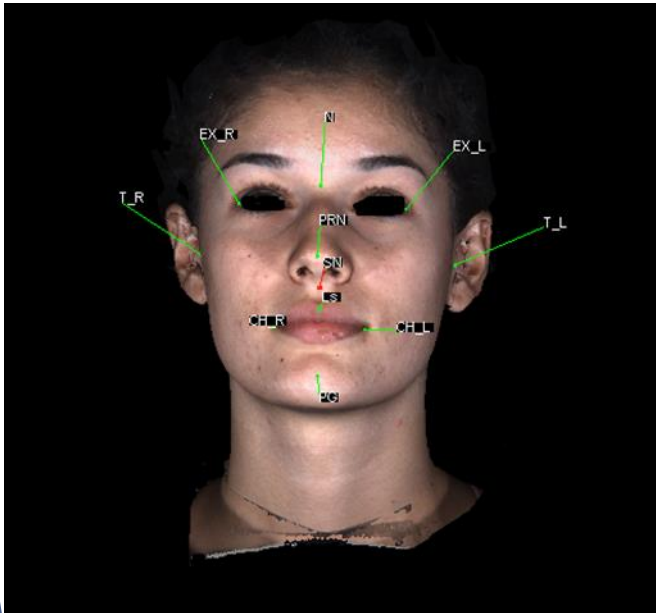
Landmark Name	Landmark Label
Nasion	N
Nasale_tip	Prn
Subnasale	Sn
Upper_lip	Ls
Pogonion	Pg
Tragion_right	T_r
Exocanthion_right	Ex_r
Commissure_right	Ch_r
Tragion_left	T_l
Exocanthion_left	Ex_l
Commissure_left	Ch_l

Methodology

Starting from the coordinates returned by the electronic system, it is possible to obtain the linear and angular measurements.

Linear Measures	
Ex_r-Ex_l	Upper facial width
Ch_r-Ch_l	Oral lenght
T_r-T_l	Middle facial width
N-T_l	Nasion – Midpoint of Tragi
Sn-Pg	Anterior lower facial height
N-Sn	Anterior upper facial 2° third height
Angular Measures	
Ex_r-N-Ex_l	Upper Facial Convexity
T_r-N-T_l	Angles between Tragi at levels of Nasion
T_l-Pg-T_r	Angles between the Tragi at the level of the Pogonion
T_l-Prn-T_r	Angles between the Tragi at the level of the Pronasal
Pg-N-Ls	Facial convexity excluding the nose
N-T_l-T_r	Angles between Tragi at levels of Nasion

The statistical analysis on the two samples was carried out through the use of MatLab software (MathWorks, version R2015a), reading the input data from a custom Excel file. The statistical test used to compare the two datasets is the **U-Mann-Whitney (MW)** with a 95% confidence interval. The choice of this test is due to the non-normal distribution of the data, as assessed through the Kolmogorov-Smirnov test.

Results

Linear Measures

	Median Miss group				Median reference group			
	Mean	Min	Max	Std dev	Mean	Min	Max	Std dev
Ex_r-Ex_l	86.36	80.98	92.25	2.65	86.84	80.02	87.64	1.88
Ch_r-Ch_l	47.04	38.11	52.53	2.98	45.59	39.33	46.75	2.12
T_r-T_l	133.15	121.50	143.62	4.68	142.49	130.00	146.91	7.33
N-T_l	112.87	106.79	120.34	3.36	116.88	110.98	118.61	2.89
Sn-Pg	46.96	41.87	52.97	2.76	48.56	48.19	48.92	0.20
N-Sn	52.48	47.03	57.57	2.59	56.19	49.28	58.61	4.04

Angular Measures

	Median Miss group				Median reference group			
	Mean	Min	Max	Std dev	Mean	Min	Max	Std dev
Ex_r-N-Ex_l	128.22	119.28	136.72	4.33	130.40	126.76	131.47	1.79
T_r-N-T_l	72.36	66.63	77.33	2.52	74.93	71.34	76.10	1.94
T_l-Pg-T_r	87.33	81.36	93.32	2.36	90.01	86.25	91.01	1.69
T_l-Prn-T_r	71.91	66.01	77.67	2.21	74.96	71.15	76.38	2.35
Pg-N-Ls	7.78	4.49	12.01	1.88	8.88	5.52	10.78	1.24
N-T_l-T_r	53.77	50.21	56.72	1.44	52.62	52.29	54.68	0.64

Results

Linear Measures			
	Median Miss group	Median reference group	p-value
Ex_r-Ex_l	85.94	87.64	0.0274
Ch_r-Ch_l	47.00	46.75	0.0062
T_r-T_l	134.06	146.91	<0.0001
N-T_l	113.40	118.61	<0.0001
Sn-Pg	46.61	48.49	<0.0001
N-Sn	52.44	58.61	<0.0001

Angular Measures			
	Median Miss group	Median reference group	p-value
Ex_r-N-Ex_l	128.48	131.47	0.0032
T_r-N-T_l	72.25	76.10	0.0005
T_l-Pg-T_r	87.54	91.01	<0.0001
T_l-Prn-T_r	72.09	76.38	<0.0001
Pg-N-Ls	7.69	8.61	0.0112
N-T_l-T_r	53.73	52.29	<0.0001

Conclusion

Using photogrammetry, a non-invasive method, 11 points were acquired from which 6 linear and 6 angular measurements were obtained.

The validity of the proposed metrics was evaluated methodologically using an approach based on statistical analysis.

In particular, results from two group of subjects, more attractive women on one side ("Miss group") and reference women ("reference group") on the other side, have been compared using a nonparametric statistical test.

The test confirmed the significance of both the chosen linear and angular measurements in distinguishing the two groups, mean and median values slightly higher in the "reference group" than in the "Miss group" for almost any parameter.

Future perspettive

Starting from this set of data, limited compared to the great potential shown by photogrammetry, it has already been possible to provide experts and clinicians with a tool to support perceptions that otherwise remain subjective.

The design of artificial intelligence algorithms to process and analyse the acquired images in order to fasten and standardize the measurement procedure and reduce inter- and intra-observer errors and disagreement while determining the measurement points.

Using images and data from different period of time, it will be possible to create classifiers that also evaluate and highlight the evolution of the concept of attractiveness so much discussed in the literature.

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Thank you!

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