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Prediction of facial attractiveness from facial proportions

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ABSTRACT

This study investigates the relationship between facial attractiveness and facial proportions. Here, we generated facial images with different proportions using computer software, hence avoided the influence of hairstyle, facial expression as well as skin tone and texture on the perception of facial attractiveness. By analyzing the relationship between the facial proportions of 432 computer generated facial images and their attractiveness ratings, here we identified the optimum proportions for an attractive female face and further established a model of predicting facial attractiveness from four principle components of facial proportions with good predictability ($R^2 = 0.64$).

1. Introduction

The question, whether there is such a thing as beauty that objectively and universally exists, has attracted debates among philosophers, psychologists and biologists for centuries [1–3]. One popular school of thought is that 'beauty is in the eye of the beholder', that individual attraction is a result of personal experience, cultural background and specific circumstances. Nevertheless, the assumption that beauty is just an arbitrary personal preference cannot explain the fact that even two-month-old infants prefer to gaze at faces that adults find attractive [4].

If there is objectivity in beauty assessment, what are there? Ancient Greeks believed that the world is beautiful because there is a certain measure, proportion, order and harmony between its elements [3]. For centuries, the Golden Ratio or Golden Proportion, a ratio of 1:1.618 has been considered as the perfect ratio for beauty, and widely applied for art and architectural design.

With regard to human body physical attractiveness, past researches showed that the body mass index (BMI) [10,11] or more precisely the body volume divided by the square of height (VHI) [12,13] is the primary cue of body attractiveness, and there is a very good agreement on the general trend of the effect of VHI on body attractiveness among Chinese and UK viewers. There exist optimum VHI values corresponding to physical fitness and fertility, although the precise values of optimum VHI could be different for different cultures [14].

As far as facial beauty is concerned, averageness [4] and symmetry [6] were found to be the important criteria. Attractiveness increased with an increasing level of averageness and symmetry. This can be understood as evolutionary pressures operate against the extremes of the population [5].

Apart from averageness and symmetry, some extreme traits, such as the peacock's tail, can be a sign of quality and health in a mate and therefore favoured in the choice of selection. Using composites of both Caucasian and Japanese faces, Perrett et al. [7] showed that the mean shape of a set of attractive faces is preferred to the mean shape of all the faces in a sample. Attractive composite faces can be made more attractive by exaggerating the shape difference from the sample mean. Therefore, an average face shape is attractive, but not optimally attractive. Human preferences could exert a directional selection pressure on the evolution of the shape of a human face. Perrett et al. [8] further showed that more feminine female and male faces are preferred to average faces. Enhanced masculine facial characteristics increased both perceived dominance and negative attributes (for example, coldness or dishonesty) relevant to relationships and paternal investment. They believed that humans have a selection pressure that limits sexual dimorphism and encourages neoteny.

It is also believed that, for attractive faces, facial measurements should follow certain defined ratios. Dated back to the renaissance period, neoclassical cannons have been proposed to be the ideal ratios of beautiful faces [16]. In popular literature, it is also claimed that beautiful faces have facial measurements close to the golden ratio [18,9,17].

Despite the popular claim that beautiful faces follow neoclassical cannons or golden ratios, it has rarely been systematically and statistically examined. The only such work is attributed to Schmid et al. [15], who recently attempted to test the above claim by relating the attractiveness of the frontal views of 420 Caucasian facial images to the ratios of facial measurements. This work was

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however not conclusive as the effects of the variations in hairstyles, skin texture, positions and expressions of the facial images on the facial attractiveness was not controlled in their experiments, and the linear regression model applied in their analysis could not model the generally nonlinear relationships and the interactions between the ratios of facial measurements. Consequently, they showed only a weak predictability ($R^2=0.2433$) of facial attractiveness even from very large number (viz. 78) of facial ratios as independent variables.

The present study is aimed at investigating only the effect of facial ratios on facial attractiveness, by excluding the effects of hairstyle, skin texture and expression, so as to test whether neoclassical cannons or golden ratios are ideal ratios for beautiful faces.

2. Experimental

2.1. Preparation of facial images

Poser software was used to create computer-generated facial images. In generating the facial images having varying facial dimensions and ratios, we first created a so called "original face" (See Fig. 1), from which some key facial dimensions are altered to generate other facial images. In order to ensure that the computer-generated facial images are realistic in facial features, the "original face" was obtained by averaging the features of the facial images of some arbitrarily chosen famous oriental ladies (from Japanese, Korean and China) available on the internet. In order to focus our present study on the effect of facial proportions, the faces were made hairless to eliminate the effects of hairstyles. The effects of hairstyles on facial attractiveness will be an area for further investigation.

Fig. 1. The "Original Face".

In order to create sufficient, but realistic variations in the facial dimensions and ratios of the facial images for our experiments, we applied gradual alteration to the "Original Face" by nine different approaches, each approach created 14 different images.

Approach 1: Mark 4 apex points at the left, right, top and bottom of the face as shown in Fig. 2(a). Shorten the width (i.e. the distance between the left and right apex points) by 4% of the width of the original face and the length (i.e. the distance between the top and bottom apex points) by 8% of the length of the original face to create a new facial image. Repeat the above procedure 13 times to create a total of 14 facial images. During this alteration, all other facial dimensions were not changed.

Approach 2: Mark 2 apex points at the left and right as shown in Fig. 2(b). Shorten the width by 4% of the width of the original face to create a new facial image. Repeat the above procedure 13 times to create a total of 14 facial images. During this alteration, all other facial dimensions were not changed.

Approach 3: Mark 2 apex points at the left and right as shown in Fig. 2(c). Increase the width by 9% of the width of the original face to create a new facial image. Repeat the above procedure 13 times to create a total of 14 facial images. During this alteration, all other facial dimensions were not changed.

Approach 4: Mark 2 apex points at the top and bottom as shown in Fig. 2(d). Shorten the length by 9% of the length of the original face to create a new facial image. Repeat the above procedure 13 times to create a total of 14 facial images. During this alteration, all other facial dimensions were not changed.

Approach 5: Mark 4 apex points at the left, right, top and bottom of the face as shown in Fig. 2(e). Increase the width (i.e. the distance between the left and right apex points) and the length (i.e. the distance between the top and bottom apex points) by 3% of the width and length of the original face, respectively, to create a new facial image. Repeat the above procedure 13 times to create a total of 14 facial images. During this alteration, all other facial dimensions were not changed.

Approach 6: Mark 2 apex points as shown in Fig. 2(f). Shorten the length of the nose by 10% of the original nose length to

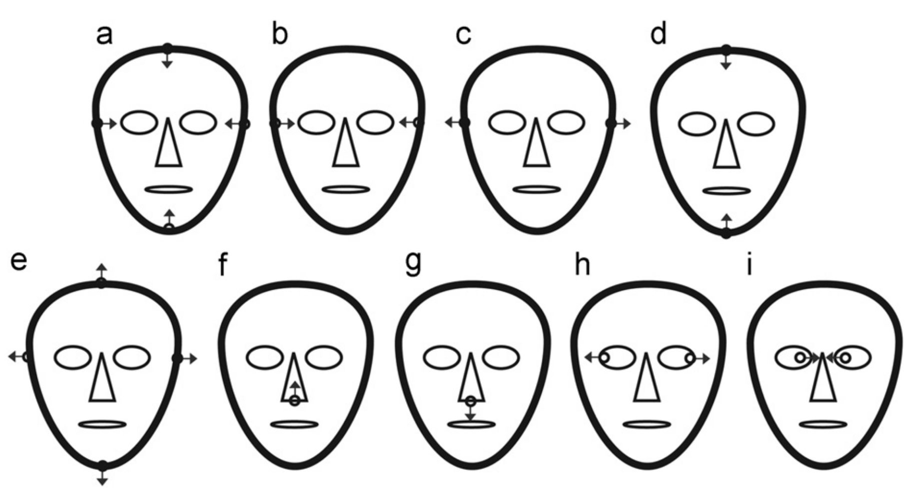

Fig. 2. Alterations of "Original Face" to generate other Facial Images. (a) Approach 1, (b) Approach 2, (c) Approach 3, (d) Approach 4, (e) Approach 5, (f) Approach 6 (g) Approach 7, (h) Approach 8 and (i) Approach 9.