Attractiveness:
What can we learn from algorithms?

Computer Vision

Nuno Fernandes

(up202109069)

Introduction

Facial Attractiveness & Algorithms

What makes a pretty face? From an evolutionary perspective, sexual dimorphism has been linked to perceived attractiveness, with more masculine men and feminine women being judged as more attractive [1,2]. Masculine traits in men are a cue to potential higher basal levels of testosterone, and as testosterone has an immunosuppressive effect, only those with good genetics could afford to develop their secondary sexual traits [3]. Femininity in women is an indicator of higher levels of estrogen, which is associated with better reproductive qualities [4]. Additionally, symmetry has also been found as one of the main predictors of facial attractiveness, both for men and women [5].

Computational models have been used to try to quantify facial attractiveness [6]. More recently, deep learning techniques have been employed to predict facial attractiveness [7,8].

Objective

The objective of the present work is to understand if algorithms replicate human decisions on dimorphic and symmetrical choices. Thus, the hypotheses are: Congruent manipulations (masculinized men and feminized women) will be rated as more attractive (H1); and Symmetrized versions will be perceived as more attractive, both for men and women (H2).

Method

Procedure

The procedure may be divided in three phases. Phase 1: Pretraining of a set of models and select the one with the best results; Phase 2: Preprocessing of images for evaluation: sexual dimorphism transformation; and symmetrical transformation.

Phase 1

Databases

The most used database for attractiveness prediction is the SCUT-FBP5500 [9], as is the one which provides the highest number of images (n = 5500). Although, the solely use of this dataset has one potential limitation as all the raters are Asians. Thus, three additional databases were included: Chicago Face Database (CFD) (n = 970) [10]; Karolinska Directed Emotional Faces (KDEF) (n = 207) [11]; and Faces (n = 172) [12]. Attractiveness ratings from all datasets were normalized to be between 0 and 1.

Models

A set of six face-recognition models were chosen from the module: tf.keras.applications. Then, all layers, except the last one, were frozen and the classification problem was changed by a regression one. The models were trained for 100 epochs, using a learning rate of 0.001 and patience setting to 30 epochs. A train/validation/test split of 60/20/20 size was used, resulting in 4110/1369/1369 images for the corresponding set. Results for the testing set may be observed in appendix A. The model with the best results was the VGG-19 (Person correlation = 0.76; RMSE = 0.094; MAE = 0.07;). Therefore, this was the selected model for the following evaluation phase.

VGG-19

The VGG-19 belongs to a series of transfer learning networks from the Visual Geometry Group Network (VGG), which also includes VGG-11, VGG-13, and VGG-16 [13]. These networks share their structure by having several convolutional layers blocks connected to three full connection layers. The VGGNet has been trained on more than 1 million images in 1000 classes. Specifically, VGG19 has five blocks of convolution layers and one last block of three fully connected layers. All blocks are connected by a 3x3 Max Pooling layer. The first (size 64x64x64) and second (size 128x128x128) blocks have two convolutional layers, while the third (size 256x256x256), fourth (size 512x512x512) and fifth (size 512x512x512) blocks have four convolutional layers.

Phase 2

Preprocess of images

The database chosen for the image manipulations was the Face Research Lab London (FRL-London) [14] which consists of 102 photos (male = 53; female = 49) from different ethnicities. This dataset has pre-delineated templates of 189-points for each image. All image manipulations were performed using computer vision techniques provided by the Psychomorph software [15].

Sexual dimorphism

Following previous research on judgment of sexual dimorphic traits, a male and a female average face were created by averaging 30 male and 30 female faces. Then, each of the male and female faces suffered a 50% linear transformation towards either the female avatar (feminized version) and the male avatar (masculinized version) [5] (see appendix B).

Symmetry

Symmetrized versions of the original photos were created by mirror reversing the original photo, and then join one side of the original photo with the opposite side of the reversed photo. Then, an oval mask was applied to avoid a possible confound effect of the symmetrized hair [16] (see appendix C).

Results

Sexual Dimorphism

Supporting previous findings, the VGG-19 predicted women as more attractive than men $F(1,100) = 56.596$, $p < .001$. With respect to the first hypothesis, we found a surprisingly interaction effect between gender and sexual dimorphism $F(2, 200) = 69.71$, $p = <.001$. The feminized versions of the women's faces (congruent condition) were perceived as more attractive than the original $t(48) = 4.852$, $p <.001$, and masculinized ones $t(48) = 5.089$, $p <.001$, as well as the feminized versions (non-congruent condition) of the men's faces compared to the original $t(52) = 7.188$, $p <.001$, and masculinized versions $t(52) = -8.70$, $p <.001$ (Figure 1). Moreover, the model reported a consistent behaviour as this was observed for 93.4% of the male cases and for 89.8% of the female cases (higher attractiveness for the feminized version compared to the masculinized version of the same face).

Symmetry

Concerning the second hypothesis, the results confirm that both for women, $t(48) = -4.66$, $p <.001$, and men, $t(52) = -9.21$, $p <.001$, symmetrized versions were judged as more attractive in comparison to the original ones, by the VGG-19 model (Figure 2). Symmetrized versions were rated as more attractive than the original version of the same photo 96.2% for the male condition and 89.8% for the female condition.

Figure 1. Interaction between gender and dimorphism

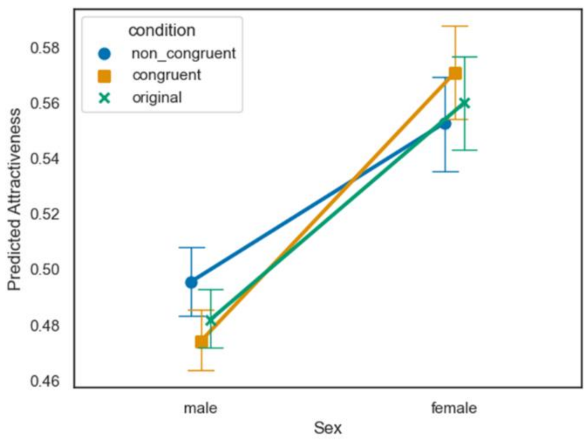
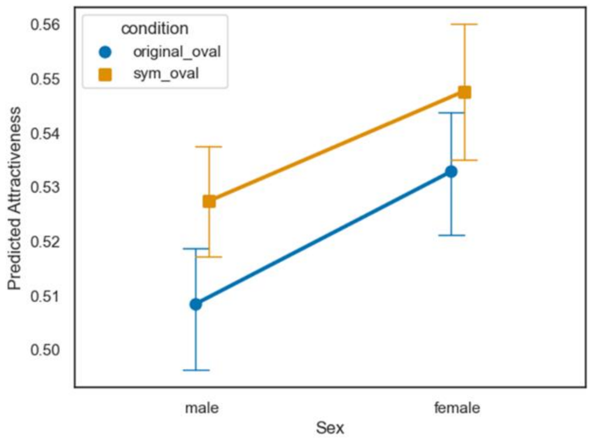


Figure 2. Interaction between gender and symmetry



Discussion

This work provides new findings towards the understanding of facial attractiveness both from an algorithmic point of view as well as from the human behavior itself. The first hypothesis was partially confirmed, which supports the evolutionary perspective for women, but provides new insights for men. These inconsistent results for men are aligned with previous studies that refute the evolutionary approach, arguing that men with more feminized traits are often preferred for long-term relationships as they may be more willing to devote more attention to descendants [17,18].

Limitations/Future directions

As possible limitations, I would like to highlight that only the last layer of the selected model, VGG-19, was trained. Despite the model showing a relatively good predictive ability (Person r = .76), it may be improved by adding and/or training more layers. Symmetrical manipulations were made using colour and shape. Thus, one may isolate this two attributes to test for its independent effects. Despite not being the original focus of the present work, I would also like to suggest three other possibilities: subset the raters by gender, and if possible, by sexual orientation; explore possible differences between ethnicities; and perform different linear transformations (e.g., 15% and 30%) in the dimorphism manipulation, to find a possible threshold for the effect.

References

[1] DeBruine Lisa M, Jones Benedict C, Little Anthony C, Boothroyd Lynda G, Perrett David I, Penton-Voak Ian S, Cooper Philip A, Penke Lars, Feinberg David R and Tiddeman Bernard P 2006. Correlated preferences for facial masculinity and ideal or actual partner's masculinity. Proc. R. Soc. B. 2731355–1360. http://doi.org/10.1098/rspb.2005.3445

[2] Fraccaro, P. J., Feinberg, D. R., DeBruine, L. M., Little, A. C., Watkins, C. D., & Jones, B. C. (2010). Correlated Male Preferences for Femininity in Female Faces and Voices. Evolutionary Psychology, 8(3). https://doi.org/10.1177/147470491000800311

[3] Ian S Penton-Voak, Jennie Y Chen (2004). High salivary testosterone is linked to masculine male facial appearance in humans, Evolution and Human Behavior, Volume 25 (4), 229-241, ISSN 1090-5138. https://doi.org/10.1016/j.evolhumbehav.2004.04.003

[4] Foo, Y., Simmons, L. & Rhodes, G. Predictors of facial attractiveness and health in humans. Sci Rep 7, 39731 (2017). https://doi.org/10.1038/srep39731

[5] Penton-Voak IS, Jones BC, Little AC, Baker S, Tiddeman B, Burt DM, Perrett DI. Symmetry, sexual dimorphism in facial proportions and male facial attractiveness. Proc Biol Sci. 2001 (1476):1617-23. doi: 10.1098/rspb.2001.1703. PMID: 11487409; PMCID: PMC1088785

[6] Bronstad, P. M., Langlois, J. H., & Russell, R. (2008). Computational Models of Facial Attractiveness Judgments. Perception, 37(1), 126–142. https://doi.org/10.1068/p5805

[7] J. Xu, L. Jin, L. Liang, Z. Feng, D. Xie and H. Mao, "Facial attractiveness prediction using psychologically inspired convolutional neural network (PI-CNN)," 2017 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), 2017, pp. 1657-1661, doi: 10.1109/ICASSP.2017.7952438

[8] L. Gao, W. Li, Z. Huang, D. Huang and Y. Wang, "Automatic Facial Attractiveness Prediction by Deep Multi-Task Learning," 2018 24th International Conference on Pattern Recognition (ICPR), 2018, pp. 3592-3597, doi: 10.1109/ICPR.2018.8545033.

[9] Liang, Lingyu & Lin, Luojun & Jin, Lianwen & Xie, Duorui & Li, Mengru. (2018). SCUT-FBP5500: A Diverse Benchmark Dataset for Multi-Paradigm Facial Beauty Prediction.

[10] Ma, Correll, & Wittenbrink (2015). The Chicago Face Database: A Free Stimulus Set of Faces and Norming Data. Behavior Research Methods, 47, 1122-1135. https://doi.org/10.3758/s13428-014-0532-5.

[11] Lundqvist, D., Flykt, A., & Öhman, A. (1998). The Karolinska Directed Emotional Faces - KDEF, CD ROM from Department of Clinical Neuroscience, Psychology section, Karolinska Institutet, ISBN 91-630-7164-9

[12] Holland, C. A. C., Ebner, N. C., Lin, T., & Samanez-Larkin, G. R. (2019). Emotion identification across adulthood using the Dynamic FACES database of emotional expressions in younger, middle aged, and older adults. Cognition and Emotion, 33, 245-257. https://doi.org/10.1080/02699931.2018.1445981.

[13] Simonyan K, Zisserman A. (2014). Very deep convolutional networks for large-scale image recognition. https://arxiv.org/abs/1409.1556

[14] DeBruine, Lisa; Jones, Benedict (2017): Face Research Lab London Set. figshare. Dataset. https://doi.org/10.6084/m9.figshare.5047666.v5

[15] B. Tiddeman and D. Perrett, Transformation of Dynamic Facial Image Sequences Using Static 2D Prototypes, The Visual Computer, Vol 18, No. 4, pp. 218-225, June 2002.

[16] David I Perrett, D.Michael Burt, Ian S Penton-Voak, Kieran J Lee, Duncan A Rowland, Rachel Edwards. (1999). Symmetry and Human Facial Attractiveness, Evolution and Human Behavior, Volume 20, Issue 5, 295-307. https://doi.org/10.1016/S1090-5138(99)00014-8.

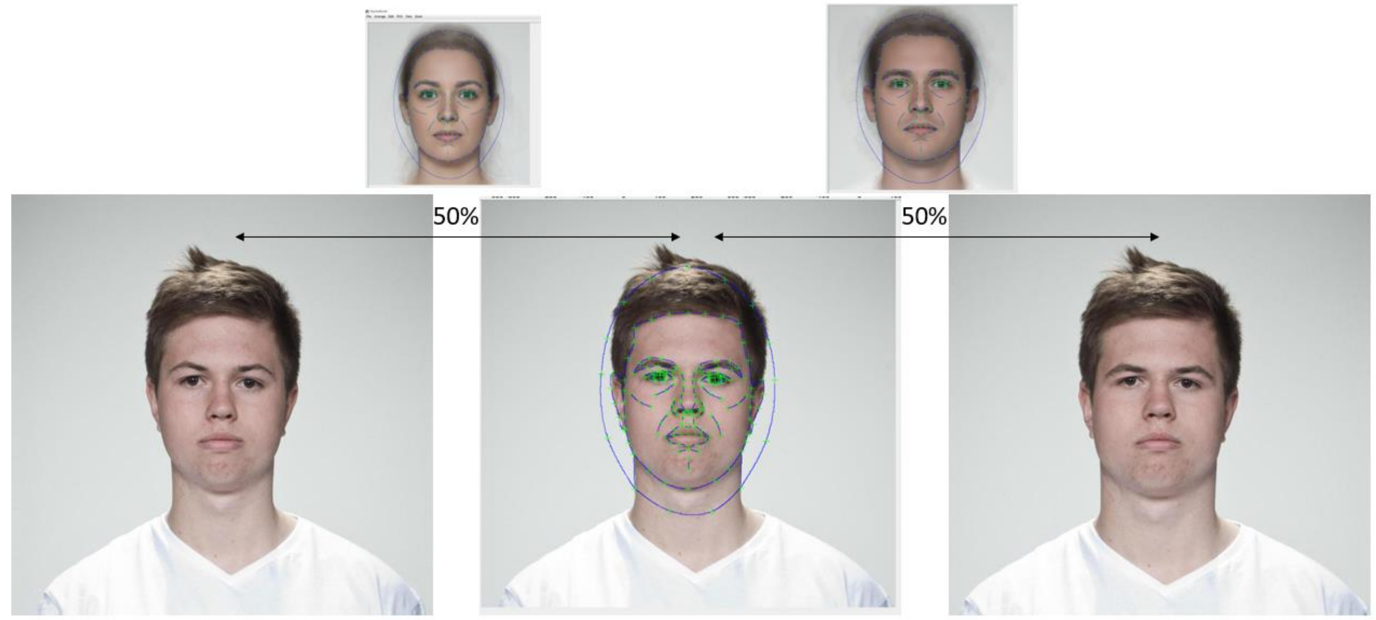
[17] Perrett, D., Lee, K., Penton-Voak, I. et al. Effects of sexual dimorphism on facial attractiveness. Nature 394, 884–887 (1998). https://doi.org/10.1038/29772

[18] Little, A. C., Burriss, R. P., Jones, B. C., DeBruine, L. M., & Caldwell, C. A. (2008). Social influence in human face preference: Men and women are influenced more for long-term than short-term attractiveness decisions. Evolution and Human Behavior, 29(2), 140–146. https://doi.org/10.1016/j.evolhumbehav.2007.11.007

Appendix A

Models	**Pearson r**	**MAE**	**RMSE**
InceptionResNetV2	0.75	0.08	0.099
MobileNetV2	0.69	0.09	0.117
EfficientNetV2B0	0.38	0.11	0.131
ResNet50	0.64	0.08	0.104
Xception	0.63	0.09	0.120
VGG19	0.76	0.07	0.094

Appendix B



Feminized Original Masculinized

Feminized Original Masculinized

Appendix C

Original

Symmetric

Original

Symmetric