



Facial attractiveness and lip morphology of Caucasian women

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ABSTRACT: Human lips are one of the most sexually dimorphic facial features. Although lip morphology is considered particularly important for female facial attractiveness no systematic empirical study has been conducted in this respect. This study aimed to investigate a relationship between female Caucasian facial attractiveness and their lip morphology. Two series of morphologically average composite portraits with digitally increased and decreased lip width and height measurements were assessed by adult men and women. Results were analysed using repeated measures ANOVA. When compared to the average lip shape both a decrease and an increase in lip width were associated with lower female facial attractiveness. A systematic increase in lip height from the lowest values to the highest, was associated with an increase in attractiveness scores. Attractiveness assessments of men and women did not differ significantly. The results show that perception of lip attractiveness may be intersexually congruent and that a variation in lip morphology may significantly affect female facial attractiveness.

KEY WORDS: lips, woman, attractiveness, averageness

Introduction

The human face is one of the most important features in general perception of human physical attractiveness (Peters et al., 2007). Consequently, a great number of studies concerning the role of physical attractiveness in human mate choice, concentrates on this part of the body (Danel and Pawłowski 2009; Kościński 2008a, 2008b; Little et al. 2011; Rhodes 2006). Facial morphological structures such as eyes, nose and the mouth initially focus the observer's attention and seem to be particularly important for the

facial attractiveness of men and women (Hassebrauck 1998) see also: (Danel and Pawłowski 2007; Frąckiewicz 2001). Other authors (Bisson and Grobbelaar 2004; Klein 2005; Michiels and Sather 1994) indicate that lip morphology is particularly important for aesthetic judgments of the female face.

The high importance of the mouth region to female facial beauty is not surprising. This area of the face is one of the most important components of facial sexual dimorphism (Burriss et al. 2007; Danel 2008; Farkas 1981; Samal et al. 2007). In contrast to several sexually dimorphic facial characteristics such as

large jawbones, prominent cheekbones and in general, longer faces, whose development can be attributed to testosterone (Verdonck et al. 1999), the feminine 'full lips' of females with a distinctive high, reddish vermilion zone are considered a marker of high oestrogens to testosterone ratio (Penton-Voak and Perrett 2000; Thornhill and Grammer 1999; Thornhill and Møller 1997).

The sole fact that lips are one of the most important female facial femininity markers, does not satisfactorily explain possible reasons for their attractiveness. This becomes clear however when the adaptive role and biological meaning of male preference for female markers of femininity such as lips are analyzed. Since sexual dimorphism develops mainly during maturation (Samal et al. 2007; Tanner 1989) prominent, red, supple and full lips are one of the visible signs of female sexual maturity. Moreover, it is suggested that in adult women during their reproductive lifespan, concentrations of sex-steroid gradually decrease and consequently age-related changes are also expected in morphological markers of hormone levels such as the lips (Thornhill and Gangestad 1999). In fact, other authors revealed that in both adult men and women the lip height and vermilion height-to-width ratio decreases with aging (Sforza et al. 2010) and that, at least in women, some age-related changes in lip morphology can be attributed to hormonal status (Caisey et al. 2008). Thus, referring to the fact that female reproductive lifespan is limited between menarche and menopause, feminine and sexually attractive lips may be considered as a female marker of youthfulness, sexual maturity and reproductive potential.

Another approach explaining the high attractiveness of female feminine lips

suggests that lips, as a part of a woman's facial sexual ornament, could be a reliable marker of high biological quality (Thornhill and Gangestad 1999). This refers to the 'double-edged sword' nature of sex hormones which on the one hand, facilitate the development of secondary sex traits, and, on the other, handicap the immune system (Folstad and Karter 1992; Giannoni et al. 2011; Jansson and Holmdahl 1998; Kanda et al. 1996; Salem 2004; Wedekind and Folstad 1994; Yesilova et al. 2000). Conspicuous sexual ornamentation certifies that an individual was able to cope with the costs related to the development and maintenance of secondary sex traits (Zahavi 1977, 1975). With such a perspective, lips as a putative morphological marker of high oestrogens to testosterone ratio could be a perceptible cue relating to high female phenotypic and genotypic quality and reliably advertising of high immunocompetence.

The above considerations highlight the significance of lips for female physical facial attractiveness. Therefore, it is surprising that according to our best knowledge there are no systematic studies on the effect of variation in female lip shape on the perception of female facial attractiveness. The main objective of our study is to determine a relationship between female lip morphology and assessment of perceived facial attractiveness. By digital manipulations of the main lip anthropometrical properties which are visible on selected female portraits we would like to reveal both inter- and intrasexual aesthetic standards of female Caucasian lips. Since human lips are one of the most sexually dimorphic facial features, we hypothesize that distinctive feminine lip shape (large width and height) would be perceived as attractive when compared to average lips in a given population.

Material and methods

Stimuli preparation

In the study we used composite portraits and preparation was carried out using scientific face-processing software 'Psychomorph' (Rowland and Perrett, 1995; Tiddeman et al., 2001). Based on the coordinates of 179 landmarks for each image, Psychomorph (University of St Andrews) generates a composite picture of averaged facial shape. In the current study, a composite portrait was averaged from 26 colour photographs of young Caucasian faces of women aged 19-23 – photographs were randomly selected from a database of 60 students.

This composite face was subjected to two separate types of graphic manipulation, changing, by digitally stretching and narrowing, width or height of the 'average' vermillion border (previously cropped along its shape and copied) in the range of $\pm 20\%$, with a 4% step. We utilized a graphic editing program Adobe Photoshop (v7.0 CE) to prepare all stimuli used in the following stages of our experiment. The 'base' values of vermilion height and width used for modification were obtained from digital measurements of the averaged lips from the com-

posite portraits. Distances corresponded to the classic anthropometric measurements of lips: *labrale superius-labrale inferius* (height) and *chelion-chelion* (width).

After resizing, modified lips were placed on the original face and underwent retouching to hide the placement marks of any overlaying face fragments. The overlapping elements had a precisely defined calibration point i.e. *stomion* (in the centre of the mouth) which enabled us to avoid relocation of the elements relative to their original position. This allowed the construction of 2 series of 10 portraits (Figures 1-2), each presenting a young woman's face with lips containing a modification only in one of two ways (height or width) and using a specified modification step.

Attractiveness judgments

The effect of lip manipulation on the perception of female facial attractiveness was studied using the Antropologus software package, which was used in another study (Lewandowski 2011). This software enables presentation of both stimuli and relevant questions on a computer screen, counterbalancing picture exposure order and time, as well as automatically generating user-friendly databases, ready to use



Fig. 1. Series of 10 portraits presenting a young woman's face with changes of lip height



Fig. 2. Series of 10 portraits presenting a young woman's face with changes of lip width

in statistical software packages. Eighty judges between the age of 19-23 years old (40 Caucasian women and 40 Caucasian men; all gave informed consent to participate in our study) assessed attractiveness of each modified faces in relation to the composite, average face of the population. In a briefing before the experiment participants were informed how to use the software and clearly instructed to compare two faces presented on the screen to each other. In the experiment, both portraits (the original i.e. 'average' and the modified one) were displayed simultaneously and randomly (in terms of the order and presentation side left-right) on the colour computer screen. On the bottom of the original composite portrait the following sentence was displayed: „Compared to me, the women opposite is...” In order to complete the sentence the subjects selected one option from a 7-step scale (1-7) which was displayed under the portraits. The extremities of the scale were defined as „much less attractive” and „much more attractive” (Figure 3). The participants were not informed that one face in each pair is always the same.

The exposure time of the portrait pairs was not limited. Between exposures

of the particular portrait pairs, a black screen was presented for 1000ms. All the subjects used the same notebook with a matt 15,4” LCD screen and a resolution of 1024x768. The distance from the computer was approx. 0.5m. There was scattered light in the room where the assessment was undertaken.

Statistical analyses

Statistical analysis was performed using repeated measures ANOVA (General Linear Model). Percent of modification (%MOD – original and 10 modified pictures) and type of modification (MOD_TYPE – height, width) were defined as repeated measures, within-subject factors and raters' gender (men, women) as a between-subject factor. The attractiveness score reflecting the attractiveness assessment of a given face in relation to the average, un-modified lip morphology was a dependent variable. The repeated measures ANOVA was used despite a minor violation of the ANOVA assumptions (normal distribution and variance homogeneity). However, ANOVA results are fairly robust for such deviations especially when sample sizes in each group are equal (Field, 2005), as it was in our study. Since the sphericity assumption was violated for %MOD ($\chi(54)=124.90$, $p<0.0001$) and an interaction between %MOD and MOD_TYPE ($\chi(54)=239.50$, $p<0.0001$) a Greenhouse-Geisser correction was applied to the final analysis. For statistically significant ANOVA main effects and interactions post-hoc analyses were performed. Since the participants assessed attractiveness of the modified faces always in reference to the unmodified average (in the studied population) lip shape the Dunnett's post-hoc test was used and the face with original, average

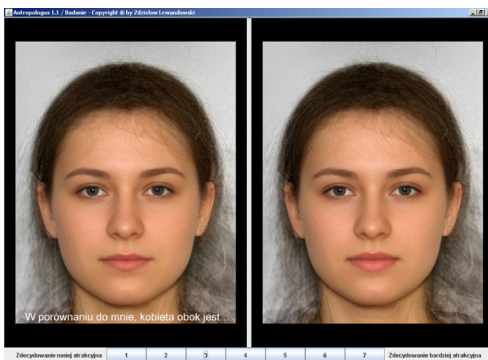


Fig. 3. Screenshot of Anthropologus software - presentation of both stimuli and relevant questions on a computer screen

lip dimensions was defined as a control category. The HSD Tukey's test was used for these post-hoc procedures which did not involve %MOD variable (i.e. in comparisons which did not include a control group). A p -value of $p < 0.05$ indicated statistically significant results. All statistical analyses were conducted in STATISTICA, version 10 (www.statsoft.com).

Results

The analysis of the ANOVA main effects revealed no statistically significant differences between the overall preferences of men and women towards the presented faces ($F(1,78)=1.96$, $p=0.17$). Nonetheless, participants' attractiveness assessments were significantly different with regard to the MOD_TYPE ($F(1, 78)=105.40$; $p < 0.0001$). The modification of lip width resulted in generally lower facial attractiveness scores when compared to the lip-height modified faces ($M=3.29$; $SE=0.19$ vs $M=3.89$; $SE=0.19$ respectively; post hoc HSD Tukey test $p=0.0001$). Also the %MOD significantly affected the attractiveness judgments ($F(7.28, 567.64)=27.02$; $p < 0.0001$). General attractiveness score (regardless of the type of lip modification) for average lip shape ($M=4.13$; $SE=0.16$) were significantly higher than attractiveness judgments of lips whose shape was decreased to both 80% ($M=2.51$, $SE=0.17$), 84% ($M=2.96$, $SE=0.16$), 88% ($M=3.17$, $SE=0.19$) or increased to 116% ($M=3.47$, $SE=0.13$) and 120% ($M=3.49$, $SE=0.14$) of the original values (all $p < 0.001$). Attractiveness of the other degrees of lip modification (i.e. 92%, $M=3.83$, $SE=0.14$; 96%, $M=3.98$, $SE=0.13$; 104%, $M=4.06$, $SE=0.14$; 108%, $M=4.09$, $SE=0.14$; 112%, $M=3.81$, $SE=0.18$) were not significant

tly different from the unmodified lips (all $p > 0.18$).

These results might have suggested that the link between attractiveness judgments and the degree of lip modification would resemble an inverted U-shape. However further analysis on the effect of the statistically significant interaction between %MOD and MOD_TYPE on beauty preferences ($F(6.95, 541.74)=23.54$; $p < 0.0001$) revealed a more detailed pattern. The inverted U-shape representing the relationship between beauty assessments and %MOD was observed for lip width modification. Both attractiveness of lips with reduced (i.e. 80%, $M=2.16$, $SE=0.13$; 84%, $M=2.79$, $SE=0.15$; 88% $M=3.07$, $SE=0.15$) and enlarged (112%, $M=3.35$, $SE=0.18$; 116%, $M=2.40$, $SE=0.15$; 120%, $M=2.24$, $SE=0.15$) width were significantly lower (all $p < 0.01$) when compared to the average lip width ($M=4.13$, $SE=0.12$). There were no statistically significant differences between portraits with average lip width and 92% ($M=3.84$, $SE=0.14$), 96% ($M=4.17$, $SE=0.13$), 104% ($M=4.09$, $SE=0.15$) and 108% ($M=3.96$, $SE=0.14$) lip width (all $p=0.79$).

In the case of lip height, the pattern of relationship between attractiveness judgments and modification level was more linear. Compared to the average lip height ($M=4.13$, $SE=0.12$), statistically significant lower attractiveness scores was observed for 80% ($M=2.85$, $SE=0.16$), 84% ($M=3.13$, $SE=0.16$), 88% ($M=3.27$, $SE=0.17$) lip height (all $p < 0.001$). Statistically non-significant differences were found between attractiveness scores of 92% ($M=3.83$, $SE=0.15$), 96% ($M=3.79$, $SE=0.12$), 104% ($M=4.04$, $SE=0.13$), 108% ($M=4.21$, $SE=0.14$), 112% ($M=4.28$, $SE=0.15$), 116% ($M=4.54$, $SE=0.15$) lip height (all $p > 0.30$). The

attractiveness of faces with the most enlarged lip height (i.e. 120%) were the highest ($M=4.75$, $SE=0.16$) and again significantly different from the unmodified portrait ($p=0.02$). Patterns of the results both for lip height and width are presented in Figure 4.

The effects of other interactions did not reach a statistical significance level i.e. %MOD and Participants' Sex ($F(7.28, 567.64)=1.94$; $p=0.06$), MOD_TYPE and Participants Sex ($F(1,78)=0.01$; $p=0.94$), %MOD and MOD_TYPE and Participants Sex ($F(6.95, 541.74)=0.77$; $p=0.66$) again suggesting that participants' sex did not affect the observed results.

Discussion

In this study we have shown that differences in lip morphology may be related to the perception of female facial aesthetics. Keeping other facial traits constant, both lip height and width significantly affect

female facial attractiveness. However, the patterns of the revealed relationships were different. In general, when compared to the attractiveness of a face with an average mouth shape, both a decrease and an increase in lip width lowered female attractiveness. A differing relationship pattern was observed for lip height. Here, attractiveness scores were the lowest for height-reduced lips. A systematic increase in lip height resulted in an increase in attractiveness judgments which were the largest for the tallest lips. Interestingly, the results were unrelated to the sex of the judges i.e. attractiveness assessments of men and women were similar.

Numerous authors suggest a considerable role for female lips in female physical attractiveness as well as their high significance in biological cueing of youth, sexual maturity, reproductive potential and health (Penton-Voak and Perrett 2000; Thornhill and Gangestad 1999; Thornhill and Møller 1997). This

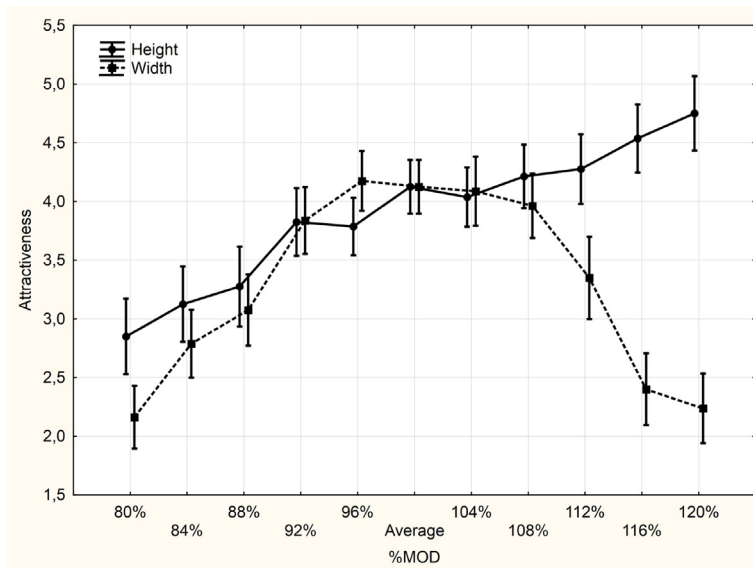


Fig. 4 The effect of %MOD and MOD_TYPE interaction on attractiveness judgments (dots and squares - means, whiskers - 0.95 CI)

may suggest that a generally 'larger' vermilion zone would be perceived as more attractive. Our results showed that such assumption may not be unambiguously true. A positive effect on attractiveness judgments may be attributed mainly via an increase in lip height but not width.

In our study, the participants assessed facial attractiveness always in relation to the average composite portrait with unmodified average lips. This allows the discussion of our results within a context of the role of averageness and distinctiveness in facial beauty. Starting with the seminal work by Galton (Galton 1878) facial averageness (i.e. resemblance to the mean facial morphology within a population) is considered attractive. The positive association between facial averageness and attractiveness was supported by many recent studies (Komori et al. 2009; Langlois and Roggman 1990; Langlois et al. 1994; Rhodes et al. 2001). However, it is also well known that average face morphology is not the most attractive (Alley and Cunningham 1991; Perrett et al. 1994). For instance, facial sexual dimorphism which enhances facial distinctiveness also affects attractiveness ratings (Perrett et al. 1998). In fact, Baudouin and Tiberghien (2004) showed that thick female lips may significantly increase attractiveness of generally average female faces. However in their study, lip shape was neither individually manipulated nor the size of other facial traits kept constant. Possible interactions with other facial features may influence the effect of lip morphology on attractiveness. Using a composite portrait in our study solved this problem. Allowing for variability in facial morphology, we clearly showed that it is an above average height of lips which increases facial attractiveness of an average female face. In contrast, deviations

from the average lip width may diminish beauty of generally average female faces.

Results showing that the highest ratings of attractiveness can be attributed to the average lip width and increased lip height also suggest that sex-specific informative role of vermilion zone is more related to the lip height than width. This means that higher than average lip height values may be a cue to such qualities such as high oestrogens to testosterone ratio, high reproductive potential, younger perceived age which are commonly linked with prominent, full lips and female facial attractiveness (Jones and Hill 1993; Penton-Voak and Perrett 2000; Thornhill and Grammer 1999). Further studies may elucidate how lip height is related to a women's hormone profile as well as how lips affect the perception of age and fertility status in female faces.

The lack of sex differences in attractiveness assessment which was revealed by our study indicates that lip morphology may similarly affect both male and female perception of women's faces. Such congruent opinions regarding lip attractiveness suggest that both sexes may correctly estimate the role of lips in female attractiveness. This knowledge may be used not only in perspective of mate choice but also in social contexts. For instance, (Guéguen, 2012), showed that women's ornamentation of lips by red lipstick may influence a number of interpersonal contacts with men and decrease the amount of time needed for first contact with opposite sex individuals. Moreover, Guéguen and Jacob (2012) revealed that using red lipstick by female waitresses increased a number and amount of tips given by male (but not female) customers. Further studies may investigate if such conscious or subconscious recognition of male beauty preferences by females is as-

sociated not only with lip colour but also with lip shape.

A possible limitation of our study may result from the fact that we analyzed the effect of lip modification on attractiveness perception using only two -dimensional pictures. In the study we did not analyze the role of lip thickness in female facial attractiveness. Since lip protuberance is possibly associated with lip shape (especially lip height) further investigation would be more accurate if the analysis includes three-dimensional stimuli.

In conclusion, our results show that lip shape affects women's facial attractiveness. When compared to average lip shape in a given population women with a close to average lip width and those with the tallest highest lip are perceived as the most attractive both by men and women. Our results show an intersexual congruency in the attractiveness perception of the vermilion zone.

Authors' contribution:

ZL worked out the idea, carried out the experiment, drafted the manuscript, edited and prepared the manuscript for publication, DPD performed statistical analysis, interpreted results, co-authored the manuscript and edited the final version for intellectual content.

Conflict of interest

The authors declare no conflict of interest.

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References

- Alley TR, Cunningham MR. 1991. Averaged faces are attractive, but very attractive faces are not average. *Psychol Sci* 2:123–5.
- Baudouin JY, Tiberghien G. 2004. Symmetry, averageness, and feature size in the facial attractiveness of women. *Acta Psychol* 117:313–32.
- Bisson M, Grobbelaar A. 2004. The esthetic properties of lips: A comparison of models and nonmodels. *Angle Orthod* 74:162–6.
- Burriss RP, Little AC, Nelson EC. 2007. 2D:4D and sexually dimorphic facial characteristics. *Arch Sex Behav* 36:377–84.
- Caisey L, Gubanova E, Camus C, Lapatina N, Smetnik V, Lévêque JL. 2008. Influence of age and hormone replacement therapy on the functional properties of the lips. *Skin Res Technol* 14:220–5.
- Danel D. 2008. Stopień maskulinizacji twarzy męskich jako wskaźnik atrakcyjności w kontekście wybranych parametrów jakości partnera w ocenie kobiet. Ph. D. Thesis: Uniwersytet Wrocławski.
- Danel D, Pawłowski B. 2007. Eye-mouth-eye angle as a good indicator of face masculinization, asymmetry, and attractiveness (*Homo sapiens*). *J Comp Psychol* 121:221–5.
- Danel D, Pawłowski B. 2009. Biologiczne znaczenie atrakcyjności twarzy, in: B Pawłowski, editor. *Biologia Atrakcyjności*. Wydawnictwa Uniwersytetu Warszawskiego, Warszawa, pp. 166–205.
- Farkas L. 1981. *Anthropometry of the head and face in medicine*. New York: Elsevier.
- Field A. 2005. *Discovering statistics using SPSS* (2nd ed.).
- Folstad I, Karter AJ. 1992. Parasites, bright males, and the immunocompetence handicap. *Am Nat* 139:603.
- Frąckiewicz W. 2001. The aesthetics of the eyes and mouth position in three-point face schema. *Anthropol Rev* 64: 93–100.
- Galton F. 1878. Composite portraits. *Nature* 18:97–100.
- Giannoni E, Guignard L, Reymond MK, Perreau M, Roth-Kleiner M, Calandra T, Roger T. 2011. Estradiol and progesterone strongly

- inhibit the innate immune response of mononuclear cells in newborns. *Infect Immun* 79:2690–8.
- Guéguen N. 2012. Does red lipstick really attract men? An evaluation in a bar. *Int J Psychol Stud* 4:206–209.
- Guéguen N, Jacob C. 2012. Lipstick and tipping behavior: When red lipstick enhance waitresses tips. *Int J Hosp Manag* 31:1333–5.
- Hassebrauck M. 1998. The visual process method: A new method to study physical attractiveness. *Evol Hum Behav* 19:111–23.
- Jansson L, Holmdahl R. 1998. Estrogen-mediated immunosuppression in autoimmune diseases. *Inflamm Res* 47:290–301.
- Jones D, Hill K. 1993. Criteria of facial attractiveness in five populations. *Hum Nat* 4:271–96.
- Kanda N, Tsuchida T, Tamaki K. 1996. Testosterone inhibits immunoglobulin production by human peripheral blood mononuclear cells. *Clin Exp Immunol* 106:410–5.
- Klein AW. 2005. In Search of the Perfect Lip: 2005. *Dermatologic Surg*. 31:1599–603.
- Komori M, Kawamura S, Ishihara S. 2009. Averageness or symmetry: Which is more important for facial attractiveness? *Acta Psychol (Amst)* 131:136–42.
- Kościński K. 2008a. Facial attractiveness: General patterns of facial preferences. *Anthropol Rev* 70:45–79.
- Kościński K. 2008b. Facial attractiveness: Variation, adaptiveness and consequences of facial preferences. *Anthropol Rev* 71:77–105.
- Langlois JH, Roggman LA. 1990. Attractive faces are only average. *Psychol Sci* 1:115–21.
- Langlois JH, Roggman LA, Musselman L. 1994. What is average and what is not average about attractive faces? *Psychol Sci* 5:214–20.
- Lewandowski Z. 2011. Changes in selected features of a male face and assessment of their influence on facial recognition. *Anthropol Anz* 68:323–37.
- Little AC, Jones BC, DeBruine LM. 2011. Facial attractiveness: evolutionary based research. *Philos Trans R Soc Lond B Biol Sci* 366:1638–59.
- Michiels G, Sather AH. 1994. Determinants of facial attractiveness in a sample of white women. *Int J Adult Orthodon Orthognath Surg* 9:95–103.
- Penton-Voak I, Perrett D. 2000. Consistency and individual differences in facial attractiveness judgements: an evolutionary perspective. *Soc Res (New York)* 67:219–44.
- Perrett DI, Lee KJ, Penton-Voak I, Rowland D, Yoshikawa S, Burt DM, Henzi SP, Castles DL, Akamatsu S. 1998. Effects of sexual dimorphism on facial attractiveness. *Nature* 394:884–7.
- Perrett DI, May KA, Yoshikawa S. 1994. Facial shape and judgements of female attractiveness. *Nature* 368:239–42.
- Peters M, Rhodes G, Simmons LW. 2007. Contributions of the face and body to overall attractiveness. *Anim Behav* 73:937–42.
- Rhodes G. 2006. The evolutionary psychology of facial beauty. *Annu Rev Psychol* 57:199–226.
- Rhodes G, Yoshikawa S, Clark A, Kieran L, McKay R, Akamatsu S. 2001. Attractiveness of facial averageness and symmetry in non-western cultures: In search of biologically based standards of beauty. *Perception* 30: 611–25.
- Rowland DA, Perrett DI. 1995. Manipulating facial appearance through shape and color. *IEEE Comput Graph Appl* 15:70–6.
- Salem ML. 2004. Estrogen, a double-edged sword: modulation of TH1- and TH2-mediated inflammations by differential regulation of TH1/TH2 cytokine production. *Curr Drug Targets Inflamm Allergy* 3:97–104.
- Samal A, Subramani V, Marx D. 2007. Analysis of sexual dimorphism in human face. *J Vis Commun Image Represent* 18:453–63.
- Sforza C, Grandi G, Binelli M, Dolci C, De Menezes M, Ferrario VF. 2010. Age- and sex-related changes in three-dimensional lip morphology. *Forensic Sci Int*. 200. doi:10.1016/j.forsciint.2010.04.050.
- Tanner J. 1989. *Foetus into man: physical growth from conception to maturity*. Castlemead Publications, Ware.
- Thornhill R, Gangestad SW. 1999. Facial attractiveness. *Trends Cogn Sci* 3:452–60.

- Thornhill R, Grammer K. 1999. The body and face of woman: one ornament that signals quality? *Evol Hum Behav* 20:105–120.
- Thornhill R, Møller AP. 1997. Developmental stability, disease and medicine. *Biol Rev Camb Philos Soc* 72:497–548.
- Tiddeman B, Burt M, Perrett D. 2001. Prototyping and transforming facial textures for perception research. *IEEE Comput Graph Appl* 21:42–50.
- Verdonck A, Gaethofs M, Carels C, De Zegher F. 1999. Effect of low-dose testosterone treatment on craniofacial growth in boys with delayed puberty. *Eur J Orthod* 21:137–43.
- Wedekind C, Folstad I. 1994. Adaptive or nonadaptive immunosuppression by sex hormones? *Am Nat* 143:936.
- Yesilova Z, Ozata M, Kocar IH, Turan M, Pekel A, Sengul A, Ozdemir IC. 2000. The effects of gonadotropin treatment on the immunological features of male patients with idiopathic hypogonadotropic hypogonadism. *J Clin Endocrinol Metab* 85:66–70.
- Zahavi A. 1977. The cost of honesty (further remarks on the handicap principle). *J Theor Biol* 67:603–5.
- Zahavi A. 1975. Mate selection—a selection for a handicap. *J Theor Biol* 53:205–14.