



## RESEARCH PAPER

**Women Use Red in Order to Attract Mates**

Pavol Prokop\* &amp; Martin Hromada†‡

\* Department of Biology, Faculty of Education, Trnava University, Trnava, Slovakia

† Department of Ecology, Faculty of Humanities and Natural Sciences, University of Prešov, Prešov, Slovakia

‡ Institute of Zoology, Poznań University of Life Sciences, Poznań, Poland

**Correspondence**

Pavol Prokop, Department of Biology, Faculty of Education, Trnava University, Priemysel'na 4, 918 43 Trnava, Slovakia.  
E-mail: pavol.prokop@savba.sk

Received: January 18, 2013

Initial acceptance: February 28, 2013

Final acceptance: May 12, 2013

(M. Herberstein)

doi: 10.1111/eth.12102

**Abstract**

Among certain non-human primates, the red-colored genitalia of females are a sexual ornament and attract males. The preference for red clothes among women is at times explained as being a parallel. We used here a within-individual design to investigate the signaling role of the color red with a sample of Slovak participants. As expected, women preferred red clothing both in real-life and would-be situations more than men. The preference for red (but not for other colors) in mating game scenarios was only significant for women, but not for men. A preference for the color red was shown in particular for clothes on the upper parts of the participants' bodies, irrespective of gender. Women who were actually involved in a romantic sexual relationship had a preference for red in would-be situations more than single women, although the menstrual cycle, the total number of lifetime sexual partners, and self-perceived attractiveness were not associated with the preference for the color red. Our results support the sexual signaling hypothesis which suggests that women use the color red to attract potential mates in a similar way as non-human primates.

Darwin (1871) suggested that brightly colored parts on animal bodies provide no advantage for the survival of their bearers but that they instead signal the quality of the respective mate to the opposite sex. Colored sexual ornaments may signal the quality or condition of their bearer (Zahavi 1975; Andersson 1994; Hill 2006). By increasing the reproductive success of brightly colored individuals, coloration ultimately increases an individual's fitness. Studies have revealed a relationship between bright coloration and reproductive success in fish (Maan et al. 2004; Magurran 2005), amphibians (Sheldon et al. 2003; Hettyey et al. 2009), reptiles (Olsson et al. 2005), birds (Bitton et al. 2007; Balenger et al. 2009; O'Brien & Dawson 2011), and mammals (Dixson et al. 1993; Bergman et al. 2009).

In contrast to almost all other mammalian orders, primates display considerable sexual dichromatism (differences in the coloring of males and females) (Bradley & Mundy 2008; Caro 2009). Females in about 10% of the primate species exhibit bright red sexual swellings around their buttocks and vulva

(Nunn 1999; Caro 2005). It is suggested that the color changes of these swellings are associated with female receptivity (reviewed by Zinner et al. 2004; Bradley & Mundy 2008). Colors on swellings can also foster male–male competition and confuse paternity (Nunn 1999). Chacma baboons (*Papio ursinus*), for example, exhibit an increased level of masturbation when exposed to an ovariectomised female wearing the artificial model of a swollen female perineum (presented in eight different colors) only when the color of the model was red (Bielert et al. 1989). In chimpanzees, maximal swelling is regarded as the estrous period (Emery & Whitten 2003), and almost all copulations are observed in this phase (Matsumoto-Oda et al. 2007).

Human skin color also seems to be influenced by sexual selection (Darwin 1871; Aoki 2002). Images of skin cropped from the cheeks of younger individuals were judged as healthier and more attractive (Fink et al. 2006, 2012; Matts et al. 2007; Stephen et al. 2009). Elevated levels of sex hormones in women are associated with increased skin vascularization

(Thornton 2002) and vasodilatory response (Char-koudian et al. 1999), which arterializes the blood in the skin (Liu et al. 1992). Thus, not surprisingly, the perception of color on clothing may also influence the perceiver's cognition, emotions, and sexual behavior (Elliot & Maier 2007). The color red is more arousing for both sexes than other colors (Wilson 1966); moreover, women dressed in red clothing are perceived as more sexually attractive to males (Elliot & Niesta 2008; Roberts et al. 2010; Guéguen & Jacob 2012), and men dressed in red are more sexually attractive for women (Elliot et al. 2010; Roberts et al. 2010). Furthermore, females interested in casual sexual relationships are more likely to exhibit red than females dedicated to facilitating a long-term, marital relationship (Elliot & Pazda 2012). This suggests that the use of the color red may be shaped by sexual selection.

A variety of women's morphological and behavioral traits are attractive to men (Barber 1995; Thornhill & Gangestad 2008; Buss 2011). The use of the eye-tracking approach revealed that men looking at the body of a woman primarily gaze at a woman's face (Hewig et al. 2008) with this subsequently followed by a viewing of the chest and finally the pelvic region (Nummenmaa et al. 2012). This suggests that the upper parts of women's bodies are considered more attractive by men than the lower parts of women's bodies. Behavioral strategies that are attractive to potential mates are influenced by the phase of the menstrual cycle (Wallen 2001; Gangestad & Thornhill 2008; Jones et al. 2008). Women dress more provocatively (Grammer et al. 2004; Haselton et al. 2007) and demonstrate a greater interest and attention to sexual stimuli (Laeng & Falkenberg 2007; Wallen & Rupp 2010) around ovulation than at other times. Another potential factor is the self-perceived attractiveness, because more attractive women report having a higher number of sexual partners than less attractive women (Thornhill & Gangestad 1994; Rhodes et al. 2005; Weeden & Sabini 2007).

While recent studies by Elliot & Niesta (2008), Elliot & Pazda (2012) have demonstrated that the color red is associated with attractiveness and interest in casual sexual relationships, we have actually taken a step forward. In this study, we have made use of a within-individual design to investigate whether the color red is an attractive signal for women, by predicting that women would preferentially wear red in certain situations. First, we hypothesized that women would wear red-colored clothes more frequently than men in real-life situations, because mate attraction may be less relevant to men's mating success than to women's (Puts 2010). Second, we predicted that if red attracts

the attention of men, then the preference for red clothes would be lower where the likelihood of meeting potential mates is low. Third, we predicted that women's preference for red would be greater around ovulation than at other times in the cycle. Fourth, the color red would be preferred specifically on the upper parts of the body because these receive greater attention from men.

## Methods

### Participants

The sample of participants (63 males and 96 females; an additional six bisexual participants, three participants with reported color blindness and one pregnant woman were excluded) consisted of 15- to 35-year-olds attending two universities and two high schools in Western, Central, and East Slovakia. The mean age of the participants was 19.97 years ( $SD = 4.06$ ). We used a convenience sample when developing a sampling strategy. The participants were asked (i) for their age; (ii) for their sex; (iii) the total number of lifetime sexual partners ('How many partners have you had penile-vaginal intercourse with?'); (iv) whether they are actually involved in a romantic sexual relationship ('Are you currently involved in a romantic sexual relationship?'); (v) and their self-perceived attractiveness ('How attractive are you on a 5 point scale' ([1 is very unattractive, 3-average and 5 is very attractive])? (Little et al. 2001); (vi) pregnancy ('Are you currently pregnant?'; this question was only generated for women), (vii) color blindness; (viii) sexual orientation (bisexual, homosexual, heterosexual). The participants did not know about our hypotheses. To mask our original intention, we instructed the participants that we were researchers interested in modern trends in clothing at the beginning of the questionnaire. The participants were assured that the survey was anonymous and that the data obtained from the questionnaires will serve exclusively for research purposes. Participation in the study was voluntary and anonymous.

### Measuring of Preference for the Red Color

An online research instrument contained a figure and a series of small squares alongside each containing one color with a total of 13 different colors so as not to restrict the preferences of the participants. Clicking on a particular square changed the color on the figure. To minimize the number of empty cells in the statistical analyses, we combined the data for

certain similar colors (if possible) as follows: red [red + pink], white, green, black [black + gray], yellow [yellow + orange], brown [brown + khaki], and blue [dark blue + light blue + purple]. The grouping of the colors was according to wavelength, with the exception of the non-color black, white, and gray. This yielded a sample of seven colors. The participants were instructed that they should imagine that the figure represents their own body. Each participant was then instructed to freely choose which color he or she preferred for the upper and lower part of the figure's body separately.

#### Measuring of Preference for Red in Real-Life Situations

To measure which color of clothes participants preferred, we asked them to provide information about the color of their actual clothes. The first question examined the actual color of clothes on the upper part of the body, while the second question examined the color of the lower part of the participant's body (What color are your actual clothes on your upper/lower part of your body)? Through these questions, we obtained data about the color of clothes of the participants during the completion of the questionnaire.

#### Measuring of Mating Game Scenarios

Participants were randomly subjected to six different scenarios based on the probability of encountering a potential mate. Three scenarios represented situations where the probability of meeting a potential mate was high (1. going to a party, 2. a date, and 3. a swimming pool) and opposite situations where the probability of meeting a potential mate was low (1. watching a movie with another man [for men] or with another women [for women], 2. working in the garden, and 3. visiting grandparents). The validity of the presented scenarios was first discussed informally with a sample of university students (both men and women) who were not involved in this research and were finally improved based on their suggestions. Specifically, participants were instructed to imagine what they would prefer to wear if the following situation would occur that day. For each situation, a separate figure with elective colors (described above) was presented. All six situations were presented to the participants in random order. We calculated the individual scores for each situation by summarizing the responses to the constituent items. For example, if the participant preferred the

color red/pink in two of three situations where the probability of meeting a potential mate was high, he or she received score 2.

#### Measuring of the Menstrual Cycle

The phase of the menstrual cycle was examined by asking the current date and the date when their last menstrual period began. These questions were only generated for women. Women were divided into high days (9–14) and low days (0–8 and 15–28) of conception risk based on self-reports of the previous onset of menstruation. These groups correspond to the follicular phase and menstruation and the luteal phase, respectively (e.g. Regan 1996), and were categorized similarly in previous research (e.g. Little et al. 2007; Rantala et al. 2010). Women were additionally asked whether they are currently using hormonal contraceptives.

#### Procedure

The current study was conducted online, which affords a high degree of anonymity, and repeatedly has been found to elicit more candid responses to questions about socially undesirable behavior and emotions than paper-and-pencil or interview methods (e.g. Locke & Gilbert 1995; Musch et al. 2001). This would seem a particular advantage in the present work where many questions were quite personal. The validity of the internet testing also revealed that internet surveys are a convenient, user-friendly, comfortable, and secure data gathering method yielding similar results to data collected with paper-and-pencil methods (e.g. Lewis et al. 2009; van Gelder et al. 2010; Campos et al. 2011). Before the web page with the online survey was made available, each participant received a unique numerical code to secure individual identity. Participants were not compensated for their participation.

#### Statistical Analyses

Continuous data were first inspected for normal distribution (Shapiro–Wilks test) and then subjected to parametric tests. When the dependent variable had binomial distribution (0 and 1), a logistic regression was performed. Partial eta-squared was used to measure the effect size (0.01 was considered small, 0.04 moderate, and 0.1 large; Huberty 2002). All the statistical tests are two-tailed and were performed with Statistica (v8, StatSoft 2007, Tulsa, OK, USA, <http://www.statsoft.com>).

**Results**

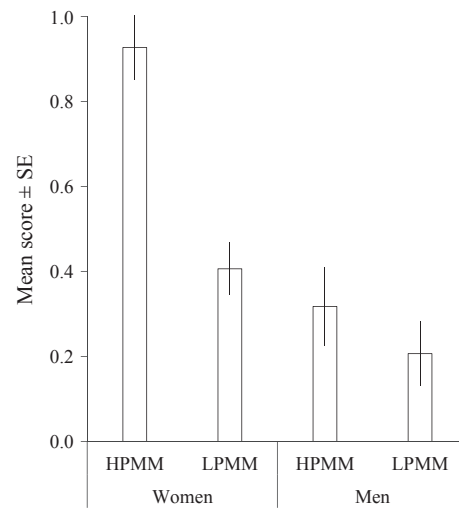
**Prediction 1: Women Prefer Red Clothes More Than Men**

As expected, women actually reported wearing red clothes significantly more frequently than men (22% vs. 8%, logistic regression, Wald's  $\chi^2 = 5.02$ ,  $df = 1$ ,  $p = 0.025$ ). The effect of age was not significant (logistic regression, Wald's  $\chi^2 = 0.14$ ,  $df = 1$ ,  $p = 0.71$ ). A series of logistic regressions indicated that there were no significant differences in the actual wearing of white, green, black, yellow, brown, and blue with respect to gender or age (all  $p > 0.1$ ).

**Prediction 2: The High Probability of Encountering a Potential Partner is Associated with a Preference for the Red Color Among Women, But Not with Men**

A 2 (gender: between-subject)  $\times$  2 (probability of encountering a potential mate: within-subject) analysis of covariance (ANCOVA) with age as a covariate indicated that women showed a preference for the red color more than men ( $F_{1,156} = 23.73$ ,  $p = 0.000003$ ,  $\eta^2 = 0.13$ ), while age did not play any role in the preference for red ( $F_{1,156} = 2.13$ ,  $p = 0.15$ ,  $\eta^2 = 0.01$ ). Within-subject results showed that there were no general differences in the preference for red between situations where the probability of meeting a potential mate was high and low although there was a non-significant tendency for red as a preference in former situations ( $F_{1,156} = 2.60$ ,  $p = 0.11$ ,  $\eta^2 = 0.02$ ). Interaction between the probability of encountering a potential mate  $\times$  gender was statistically significant ( $F_{1,156} = 8.36$ ,  $p = 0.004$ ,  $\eta^2 = 0.05$ , Fig. 1), indicating that women had a preference for red in situations where the probability of meeting a potential mate was high more than when the probability was low (Tukey post-hoc test,  $p < 0.0001$ ), although men showed no significant shift in the preference for red between the two types of situations (Tukey post-hoc test,  $p = 0.75$ ). Interaction term between the probability of encountering a potential mate  $\times$  age was not significant ( $F_{1,156} = 0.53$ ,  $p = 0.47$ ,  $\eta^2 = 0.003$ ). A series of ANCOVAs for other colors yielded no significant results (including interactions between variables) (all  $p > 0.06$ ). Only the color brown was preferred more as the age of participants increased ( $F_{1,156} = 6.74$ ,  $p = 0.01$ ,  $\eta^2 = 0.04$ ). Overall, these results provide strong statistical support for Prediction 2.

Results presented in Table 1 show that women preferred red particularly at would-be parties and



**Fig. 1:** The preference for the color red with respect to gender and the mating game scenario (HPMM = high probability of meeting a potential mate, LPMM = low probability of meeting a potential mate).

**Table 1:** A descriptive analysis of the preference for red and non-red in would-be situations where the probability of meeting a potential mate was high (HPMM) and low (LPMM). The numbers are sample sizes

| Color   | HPMM  |      |               | LPMM  |        |              |
|---------|-------|------|---------------|-------|--------|--------------|
|         | Party | Date | Swimming pool | Movie | Garden | Grandparents |
| Red     |       |      |               |       |        |              |
| Women   | 31    | 36   | 22            | 17    | 7      | 15           |
| Men     | 9     | 6    | 5             | 6     | 2      | 5            |
| Non-red |       |      |               |       |        |              |
| Women   | 96    | 96   | 90            | 95    | 96     | 95           |
| Men     | 63    | 61   | 63            | 63    | 63     | 62           |

dates, and the color red was least preferred as clothing for gardening.

**Prediction 3: Women in the Fertile Phase of the Menstrual Cycle Prefer Red Clothes More Than Women in the Non-Fertile Phase of the Menstrual Cycle**

A total of 15 women reported the use of hormonal contraceptives and were excluded from further analyses. Multiple logistic regression with the actual wearing of red clothes (coded as 1) vs. the clothes of other colors (coded as 0) as the dependent variable revealed that neither conception risk, having been actually involved in a romantic relationship, self-perceived attractiveness, age, or the total number of sexual partners influenced the actual wearing of red clothes



in real-life situations (Wald  $\chi^2 = 0.02, 0.29, 0.91, 0.30$  and  $0.79$ , all  $p > 0.34$ , respectively).

When the data were reanalyzed with 2 (conception risk: between-subject)  $\times$  2 (having been involved in a romantic relationship: between-subject)  $\times$  2 (probability of encountering a potential mate: within-subject) ANCOVA with age, self-perceived attractiveness, and the total number of sexual partners as covariates, only having been involved in a romantic relationship indicated a significant effect on the preference for the color red in would-be situations ( $F_{1,75} = 4.61$ ,  $p = 0.03$ ,  $\eta^2 = 0.06$ ). Single women showed a preference for the color red in would-be situations less than those involved in a romantic relationship. Other predictors (including interaction terms) showed non-significant effects on the preference for red (all  $p > 0.26$ ). Prediction 3 was therefore not supported.

#### Prediction 4: Participants Wear Red Clothes on the Upper Parts of Their Bodies

Previous analyses indicated that only the color red was exclusively associated with mating game scenarios; thus, further analyses are restricted to this color. There was an overall prevalence for actual wearing of red clothes on the upper parts of the body in women (the entire sample,  $n = 96$  women with those who did not wear red excluded; upper part:  $n = 15$ , lower part,  $n = 2$ , upper + lower part,  $n = 4$ ; binomial test after upper + lower part of the body excluded,  $p < 0.01$ ), but not in men (the entire sample,  $n = 63$  men with those who did not wear red excluded; upper part:  $n = 4$ , lower part,  $n = 1$ , upper + lower part,  $n = 0$ ; binomial test after upper + lower part of the body excluded,  $p = 0.38$ ). When women who wore red clothes on both parts of the body were removed, the difference in wearing red on the upper parts of the body was not significantly different between the sexes (Fisher exact test,  $p = 1.00$ ). This supports our prediction that red clothes are worn preferably on the upper parts of bodies although this preference is not restricted exclusively to women.

#### Discussion

The significance of human preferences for certain colors is not yet clear (Elliot & Maier 2007), and through combining data here from would-be and real-life situations, we found support for the hypothesis that the color red may be used by women as a sexual signal to attract a potential mate.

Consistent with our prediction, women reported wearing red clothes more frequently than men in real-life conditions which suggests that the preference for the color red is sex specific (Hurlbert & Ling 2007). Interestingly, there were no gender differences in the preference for the other seven color categories which means that the preference for red in women is unique as compared with the preference for any other color. Further research is required to examine the preference for the color red in real mating and non-mating contexts. For example, it is not clear whether women in real-life situations prefer red dresses when they engage in flirting with men, and/or whether the color red is less preferred in common, non-mating situations.

In the would-be situations, we compared three mating game scenarios with three non-mating game scenarios. We found clear support for the idea that women are more likely to wear red when the probability of encountering a potential mate is high, and this is consistent with the idea that the red color could function as a sexual signal (Elliot & Pazda 2012). While Elliot and Pazda have determined that the preference for the color red is associated with an interest in casual sexual relationships in women, our results suggest that the preference for red is not only context dependent, but that it is also statistically significant within-individual variation. Specifically, the same woman seems to have a preference for red in mating game scenarios more frequently than in non-mating scenarios. By increasing her own attractiveness with red clothing (Elliot & Niesta 2008; Roberts et al. 2010; Guéguen & Jacob 2012), she may have a greater chance to attract a potential mate. Although this association seems probable, we did not include women's attractiveness rating; hence, the connection between wearing red (this study) and being rated as more attractive (e.g. Elliot & Niesta 2008) is indirect. In contrast to Roberts et al. (2010) who determined that the color black is also highly attractive to the opposite sex, we have not discovered any associations between this color and the mating context.

In light of the fact that women's mating behavior is influenced by the phase of the menstrual cycle (e.g. Jones et al. 2005, 2008; Haselton & Gangestad 2006; Gangestad & Thornhill 2008; Guéguen 2009) and women around ovulation are more sensitive to sexual stimuli (Laeng & Falkenberg 2007; Wallen & Rupp 2010), it can be assumed that the preference for the color red, as a potential sexual signal (Elliot & Pazda 2012; this study), could be influenced by conception risk. We failed to find support for this idea in both real-life and would-be situations. The proportion of

women who were actually in the fertile phase of the menstrual cycle and reported actually wearing red clothes was similar to the proportion of women who actually wore red, but were in the non-fertile phase of the menstrual cycle. The would-be situations also failed to indicate any associations between the preference for the color red and the menstrual cycle. We would expect that more precise physiological measurements of the timing of ovulation (see Gangestad et al. 2002) would be required before a firm conclusion can be drawn. Alternatively, women can mask ovulation to maintain constant attractiveness and paternal investment through paternity uncertainty throughout the menstrual cycle (Gangestad & Thornhill 2008) and, if so, then no differences in the preference for the color red in the high conception risk phase would be expected.

Women involved in a romantic sexual relationship preferred the color red in would-be situations more than single women. This finding does not contradict the sexual signaling hypothesis (Elliot & Niesta 2008; Elliot & Pazda 2012), because women engaged in a romantic sexual relationship are, in fact, expected to attract (at least) their actual mates. Additional data about single women, which would indicate whether they actually have an interest in being in a committed romantic relationship, are required. Alternatively, if women perceive other women in red as sexually receptive, then women in red should be under stronger intrasexual competition than women wearing other colors. This idea has never been examined.

Elliot & Pazda (2012) have determined that women interested in casual sexual relationships were more likely to prominently exhibit red than women on a website dedicated to facilitating marital relationships. Both interest in casual sex, the total number of lifetime sexual partners and self-perceived attractiveness, are correlated (Rhodes et al. 2005; Weeden & Sabini 2007); thus, a correlation with the preference for red would be expected. We did not find any association, however, between preferences for red, the reported number of sexual partners, and self-perceived attractiveness in real-life situations or in would-be scenarios. This suggests that the preference for red is motivated by the mating game, rather than an individual's history of sexual relationships or perceived attractiveness. Perhaps a more detailed data (e.g. a preference for provocative dressing, see Grammer et al. 2004; Haselton et al. 2007) would produce more accurate results.

Finally, we predicted that red clothes would dominate on the upper parts of participant's bodies. An analysis of both real-life and would-be scenarios

supported our prediction that the color red is preferred on the upper parts of bodies, although there is not a restriction for this preference among women. These findings are consistent with the overall attractiveness of human bodies; men looking at the body of a woman primarily gaze at a woman's face and chest (Hewig et al. 2008; Nummenmaa et al. 2012), and the upper parts seem to be most attractive for men. From an evolutionary perspective, this preference may be driven by bipedal locomotion in humans and a shift from primary attraction on the part of males to female genitalia (i.e. the lower parts of bodies) to permanent breasts (i.e. the upper parts of bodies) (Morris 1967).

To conclude, our research supports the idea that the preference for the color red is associated with sexual interest to potential mates (Elliot & Niesta 2008; Elliot & Pazda 2012). Women seem to prefer red clothes particularly when the expected likelihood of encountering a potential mate is relatively high, and these shifts in wearing preferences are exclusively limited to the color red. We did not find similar, context-dependent preferences among men, which strengthens the parallel with the sexual strategies of females in non-human primates. In contrast to other primates, women prefer the color red predominantly on the upper parts of their bodies which can be explained by the evolution of bipedal locomotion and the consequent shift of attractiveness from genitalia to permanent breasts and faces. What amount of red makes women more attractive, and whether men actually consider women dressed in red on the upper parts of bodies more attractive than those dressed with red on the lower parts of bodies, remains to be studied.

### Acknowledgements

We are extremely grateful to the Editor and two anonymous referees for insightful comments and suggestions. PP was partly supported by grant VEGA no. 1/0137/11. MH was supported by grant ITMS2 6110230069. This study has been approved by the institutional review board at Trnava University (license no. 038/11).

### Literature Cited

- Andersson, M. 1994: *Sexual Selection*. Princeton Univ. Press, Princeton, NJ.
- Aoki, K. 2002: Sexual selection as a cause of human skin colour variation: Darwin's hypothesis revisited. *Ann. Hum. Biol.* **29**, 589–608.

- Balenger, S. L., Johnson, L. S. & Masters, B. S. 2009: Sexual selection in a socially monogamous bird: male color predicts paternity success in the mountain bluebird, *Sialia currucoides*. *Behav. Ecol. Sociobiol.* **63**, 403–411.
- Barber, N. 1995: The evolutionary psychology of physical attractiveness: sexual selection and human morphology. *Ethol. Sociobiol.* **16**, 395–424.
- Bergman, T. J., Ho, L. & Beehner, J. C. 2009: Chest color and social status in male geladas (*Theropithecus gelada*). *Int. J. Primatol.* **30**, 791–806.
- Bielert, C., Girolami, L. & Jowell, S. 1989: An experimental examination of the colour component in visually mediated sexual arousal of the male chacma baboon (*Papio ursinus*). *J. Zool.* **219**, 569–579.
- Bitton, P.-P., O'Brien, E. L. & Dawson, R. D. 2007: Plumage brightness and age predict extrapair fertilization success of male tree swallows, *Tachycineta bicolor*. *Anim. Behav.* **74**, 1777–1784.
- Bradley, B. J. & Mundy, N. I. 2008: The primate palette: the evolution of primate coloration. *Evol. Anthropol.* **17**, 97–111.
- Buss, D. M. 2011: *Evolutionary Psychology. The Science of the Mind* (4th edn). Prentice Hall, New York.
- Campos, J. A. D. B., Zucoloto, M. L., Bonafe, F. S. S., Jordani, P. C. & Maroco, J. 2011: Reliability and validity of self-reported burnout in college students: a cross randomized comparison of paper-and-pencil vs. online administration. *Comp. Hum. Behav.* **27**, 1875–1883.
- Caro, T. 2005: The adaptive significance of coloration in mammals. *Bioscience* **55**, 125–136.
- Caro, T. 2009: Contrasting coloration in terrestrial mammals. *Philos. Trans. Roy. Soc. B.* **364**, 537–548.
- Charkoudian, N., Stephens, D. P., Pirkle, K. C., Kosiba, W. A. & Johnson, J. M. 1999: Influence of female reproductive hormones on local thermal control of skin blood flow. *J. Appl. Physiol.* **87**, 1719–1723.
- Darwin, C. 1871: *The Descent of Man, and Selection in Relation to Sex*. John Murray, London.
- Dixon, A. F., Bossi, T. & Wickings, E. J. 1993: Male dominance and genetically determined reproductive success in the mandrill (*Mandrillus sphinx*). *Primates* **34**, 525–532.
- Elliot, A. J. & Maier, M. A. 2007: Color and psychological functioning. *Curr. Dir. Psychol. Sci.* **16**, 250–254.
- Elliot, A. J. & Niesta, D. 2008: Romantic red: red enhances men's attraction to women. *J. Pers. Soc. Psychol.* **95**, 1150–1164.
- Elliot, A. J. & Pazda, A. D. 2012: Dressed for sex: red as a female sexual signal in humans. *PLoS ONE* **7**, e34607.
- Elliot, A. J., Kayser, D. N., Greitemeyer, T., Lichtenfeld, S., Gramzow, R. H., Maier, M. A. & Liu, H. J. 2010: Red, rank, and romance in women viewing men. *J. Exp. Psychol. Gen.* **139**, 399–417.
- Emery, M. A. & Whitten, P. L. 2003: Size of sexual swellings reflects ovarian function in chimpanzees (*Pan troglodytes*). *Behav. Ecol. Sociobiol.* **54**, 340–351.
- Fink, B., Grammer, K. & Matts, P. J. 2006: Visual skin color distribution plays a role in the perception of age, attractiveness, and health of female faces. *Evol. Hum. Behav.* **27**, 433–442.
- Fink, B., Bunse, L., Matts, P. J. & D'Emiliano, D. 2012: Visible skin colouration predicts perception of male facial age, health and attractiveness. *Int. J. Cosmet. Sci.* **34**, 307–310.
- Gangestad, S. W. & Thornhill, R. 2008: Human oestrus. *Proc. Roy. Soc. Lond.* **275**, 991–1000.
- Gangestad, S. W., Thornhill, R. & Garver, C. E. 2002: Changes in women's sexual interests and their partner's mate-retention tactics across the menstrual cycle: evidence for shifting conflicts of interest. *Proc. Roy. Soc. Lond.* **269**, 975–982.
- van Gelder, M. M. H. J., Bretveld, R. W. & Roeleveld, N. 2010: Web-based questionnaires: the future in epidemiology? Internet versus paper-and-pencil survey methods in psychological experiments: equivalence testing of participant responses to health-related messages. *Am. J. Epidemiol.* **172**, 1292–1298.
- Grammer, K., Renninger, L. & Fischer, B. 2004: Disco clothing, female sexual motivation, and relationship status: is she dressed to impress? *J. Sex Res.* **41**, 66–74.
- Guéguen, N. 2009: Menstrual cycle phases and female receptivity to a courtship solicitation: an evaluation in a nightclub. *Evol. Hum. Behav.* **30**, 351–355.
- Guéguen, N. & Jacob, C. 2012: Clothing color and tipping: gentlemen patrons give more tips to waitresses with red clothes. *Int. J. Hospital. Manag.* **31**, 1333–1335.
- Haselton, M. G. & Gangestad, S. W. 2006: Conditional expression of women's desires and men's mate guarding across the ovulatory cycle. *Horm. Behav.* **49**, 509–518.
- Haselton, M. G., Mortezaie, M., Pillsworth, E. G., Bleske-Rechek, A. & Frederick, D. A. 2007: Ovulatory shifts in human female ornamentation: near ovulation, women dress to impress. *Horm. Behav.* **51**, 40–45.
- Hettyey, A., Herczeg, G., Laurila, A., Crochet, P. A. & Merilä, J. 2009: Body temperature, size, nuptial colouration and mating success in male Moor Frogs (*Rana arvalis*). *Amphib. Reptil.* **30**, 37–43.
- Hewig, J., Trippe, R. H., Hecht, H., Straube, T. & Miltner, W. H. R. 2008: Gender differences for specific body regions when looking at men and women. *J. Nonv. Behav.* **32**, 67–78.
- Hill, G. E. 2006: Female mate choice for ornamental coloration. In: *Bird Coloration*, Vol. 2 (Hill, G. E. & McGraw, K. J., eds). Harvard Univ. Press, Cambridge, pp. 137–200.
- Huberty, C. J. 2002: A history of effect sizes indices. *Educ. Psychol. Meas.* **62**, 227–240.
- Hurlbert, A. C. & Ling, Y. L. 2007: Biological components of sex differences in color preference. *Curr. Biol.* **17**, 623–625.

- Jones, B. C., Perrett, D. I., Little, A. C., Boothroyd, L. G., Cornwell, R. E., Feinberg, D. R., Tiddeman, B. P., Whiten, S., Pitman, R. M., Hillier, S. G., Burt, D. M., Stirrat, M. R., Law Smith, M. J. & Moore, F. R. 2005: Menstrual cycle, pregnancy and oral contraceptive use alter attraction to apparent health in faces. *Proc. Roy. Soc. Lond.* **272**, 347–354.
- Jones, B. C., DeBruine, L. M., Perrett, D. I., Little, A. C., Feinberg, D. R. & Law Smith, M. J. 2008: Effects of menstrual cycle on face preferences. *Arch. Sex. Behav.* **37**, 78–84.
- Laeng, B. & Falkenberg, L. 2007: Women's pupillary responses to sexually significant others during the hormonal cycle. *Horm. Behav.* **52**, 520–530.
- Lewis, I., Watson, B. & White, K. M. 2009: Internet versus paper-and-pencil survey methods in psychological experiments: equivalence testing of participant responses to health-related messages. *Aust. J. Psychol.* **61**, 107–116.
- Little, A. C., Burt, D. M., Penton-Voak, I. S. & Perrett, D. I. 2001: Self-perceived attractiveness influences human female preferences for sexual dimorphism and symmetry in male faces. *Proc. Roy. Soc. Lond.* **268**, 39–44.
- Little, A. C., Jones, B. C. & Burriss, R. P. 2007: Preferences for masculinity in male bodies change across the menstrual cycle. *Horm. Behav.* **31**, 633–639.
- Liu, D., Moberg, E., Kollind, M., Lins, P. E., Adamson, U. & MacDonald, I. A. 1992: Arterial, arterialed venous, venous and capillary blood glucose measurements in normal man during hyperinsulinaemic euglycaemia and hypoglycaemia. *Diabetologia* **35**, 287–290.
- Locke, S. D. & Gilbert, B. O. 1995: Method of psychological assessment, self-disclosure, and experiential differences: a study of computer, questionnaire, and interview assessment formats. *J. Soc. Behav. Personal.* **10**, 255–263.
- Maan, M. E., Seehausen, O., Soderberg, L., Johnson, L., Ripmeester, E. A. P., Mrosso, H. D., Taylor, M. I., van Dooren, T. J. & van Alphen, J. J. 2004: Intraspecific sexual selection on a speciation trait, male coloration, in the Lake Victoria cichlid *Pundamilia nyererei*. *Proc. Roy. Soc. Lond.* **271**, 2445–2452.
- Magurran, A. E. 2005: *Evolutionary Ecology*. The Trinidadian Guppy. Oxford Univ. Press, Oxford, UK.
- Matsumoto-Oda, A., Hamai, M., Hayaki, H., Hosaka, K., Hunt, K. D., Kasuya, E., Kawanaka, K., Mitani, J. C., Takasaki, H. & Takahata, Y. 2007: Estrus cycle asynchrony in wild female chimpanzees, *Pan troglodytes schweinfurthii*. *Behav. Ecol. Sociobiol.* **61**, 661–668.
- Matts, P. J., Fink, B., Grammer, K. & Burguest, M. 2007: Color homogeneity and visual perception of age, health, and attractiveness of female facial skin. *J. Am. Acad. Dermatol.* **57**, 977–984.
- Morris, D. 1967: *The Naked Ape*. McGraw-Hill, New York.
- Musch, J., Broder, A. & Klauer, K. C. 2001: Improving survey research on the world-wide web using the randomized response technique. In: *Dimensions of Internet Science* (Reips, U.-D. & Bosnjak, M., eds). Pabst Science Publishers, Lengerich pp. 179–192.
- Nummenmaa, L., Hietanen, J. K., Santtila, P. & Hyona, J. 2012: Gender and visibility of sexual cues influence eye movements while viewing faces and bodies. *Arch. Sex. Behav.* **41**, 1439–1451.
- Nunn, C. L. 1999: The evolution of exaggerated sexual swellings in primates and the graded-signals hypothesis. *Anim. Behav.* **58**, 229–246.
- O'Brien, E. L. & Dawson, R. D. 2011: Plumage color and food availability affect male reproductive success in a socially monogamous bird. *Behav. Ecol.* **22**, 66–72.
- Olsson, M., Madsen, T., Wapstra, E., Silverin, B., Ujvari, B. & Wittzell, H. 2005: MHC, health, color, and reproductive success in sand lizards. *Behav. Ecol. Sociobiol.* **58**, 289–294.
- Puts, D. A. 2010: Beauty and the beast: mechanisms of sexual selection in humans. *Evol. Hum. Behav.* **31**, 157–175.
- Rantala, M. J., Polkki, M. & Rantala, L. M. 2010: Preference for human male body hair changes across the menstrual cycle and menopause. *Behav. Ecol.* **21**, 419–423.
- Regan, P. C. 1996: Rhythms of desire: the association between menstrual cycle phases and female sexual desire. *Can. J. Hum. Sex.* **5**, 145–156.
- Rhodes, G., Simmons, L. W. & Peters, M. 2005: Attractiveness and sexual behavior: does attractiveness enhance mating success? *Evol. Hum. Behav.* **26**, 186–201.
- Roberts, S. C., Owen, R. C. & Havlicek, J. 2010: Distinguishing between perceiver and wearer effects in clothing color-associated attributions. *Evol. Psychol.* **8**, 350–364.
- Sheldon, B. C., Arponen, H., Laurila, A., Crochet, P.-A. & Merilä, J. 2003: Sire coloration influences offspring survival under predation risk in the moorfrog. *J. Evol. Biol.* **16**, 1288–1295.
- Stephen, I. D., Coetzee, V., Law Smith, M. & Perrett, D. I. 2009: Skin blood perfusion and oxygenation colour affect perceived human health. *PLoS ONE* **4**, e5083.
- Thornhill, R. & Gangestad, S. W. 1994: Fluctuating asymmetry correlates with lifetime sex partner numbers and age at first sex in *Homo sapiens*. *Psychol. Sci.* **5**, 297–302.
- Thornhill, R. & Gangestad, S. W. 2008: *The Evolutionary Biology of Human Female Sexuality*. Oxford Univ. Press, New York.
- Thornton, M. J. 2002: The biological actions of oestrogens on skin. *Exp. Dermatol.* **11**, 487–502.



- Wallen, K. 2001: Sex and context: hormones and primate sexual motivation. *Horm. Behav.* **40**, 339—357.
- Wallen, K. & Rupp, H. A. 2010: Women's interest in visual sexual stimuli varies with menstrual cycle phase at first exposure and predicts later interest. *Horm. Behav.* **57**, 263—268.
- Weeden, J. & Sabini, J. 2007: Subjective and objective measures of attractiveness and their relation to sexual behavior and sexual attitudes in university students. *Arch. Sex. Behav.* **36**, 79—88.
- Wilson, G. D. 1966: Arousal properties of red versus green. *Percept. Mot. Skills* **23**, 942—949.
- Zahavi, A. 1975: Mate selection - a selection for a handicap. *J. Theor. Biol.* **53**, 205—214.
- Zinner, D. P., van Schaik, C. P., Nunn, C. L. & Kappeler, P. M. 2004: Sexual selection and exaggerated sexual swellings of female primates. In: *Sexual Selection in Primates: New and Comparative Perspectives* (Kappeler, P. M. & van Schaik, C. P., eds). Cambridge Univ. Press, Cambridge, pp. 71—89.