

Target Articles

Hue and Luminosity of Human Skin: A Visual Cue for Gender Recognition and Other Mental Tasks

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Abstract

Face recognition takes place within a distinct heritable module of the brain and includes the ability to distinguish between male and female human faces. To identify gender, this module targets a number of sexually dimorphic features, particularly the hue and luminosity of facial skin. Men look browner and ruddier in hue because melanin and blood are more present in their skin's outer tissues. Women have a higher luminous contrast between their facial skin and their lips and eyes. Hue seems to provide a "fast channel" for gender recognition. If the observer is too far away or the lighting too dim, the brain switches to the "slow channel" and targets luminosity. In addition to assisting gender recognition, the skin's hue and luminosity may also alter the observer's mental state in a number of areas, ranging from sexual attraction to emotional distancing.

Keywords: Face Recognition; Gender Recognition; Sex Differences; Sex Hormones; Sexual Dimorphism; Skin Color

Introduction

An old Christian manuscript recounts the story of a man who went to live in a monastery with his infant son. As the boy became a young man, he began to see strange beings in his dreams. One day, he ventured with his father into the

outside world. On seeing some women, he exclaimed: "Father, those are the ones who would come to see me at night!" (Regnault, 1966, p. 73).

We do not learn to recognize the human face. Nor do we learn to identify whether it is male or female. This type of image is primarily recognized via an innate module that functions independently of other cognitive abilities. If this module ceases to function following brain damage, the result is a syndrome called prosopagnosia: the patient may seem to be like everyone else but will not recognize a normally positioned face more easily than any other object, including an upside-down face (Farah, 1996; Little et al., 2005; Pascalis & Kelly, 2008; Zhu et al., 2009). At the other extreme are "super-recognizers" who are as good at face recognition as prosopagnosics are bad (Russell, Duchaine, & Nakayama, 2009).

This should be no surprise. If an object appears in our visual field often enough, while being significant enough to our existence, we stand to gain by recognizing it automatically instead of having to learn its key features. Thus, natural selection will gradually hardwire recognition of familiar objects, like the human face.

This hardwiring can be thought of as a 'template' that responds to a limited set of visual cues. Although men and women differ physiologically in many ways, most of these differences are not readily visible and play no role in recognition of sexual identity. The face-recognition module does not recognize male and female faces, *per se*, but rather two variants of a common mental template. This is sexual identity as a psychological and almost caricatured reality and not as a biological one. Thus, the terms 'gender recognition' and 'gender discrimination' are the ones most often used in this field of research.

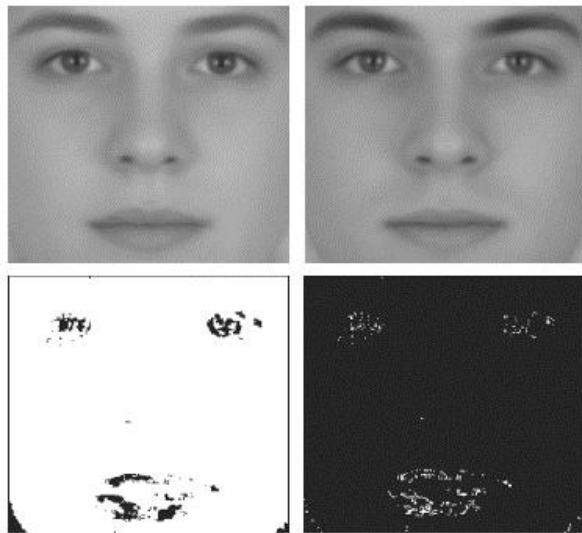
To recognize an object as a human face, the face-recognition module targets certain features like the eyes and the mouth (Pascalis & Kelly,

2008). Another key feature is skin color, specifically hue and luminosity, which seem especially crucial to telling male and female faces apart. In terms of hue, a male face is browner and ruddier than a female one because melanin and blood are more present in the skin's outer tissues (Edwards & Duntley, 1939). In terms of luminosity, a female face has higher contrast between the skin and the lips or eyes (Dupuis-Roy et al., 2009; Russell, 2003). Hue provides a fast visual channel for gender recognition (Dupuis-Roy et al., 2009; Nestor & Tarr, 2008a; Nestor & Tarr, 2008b; Tarr et al., 2001; Tarr, Rossion, & Doerschner, 2002). If the observer is too far away or the lighting too dim, the brain switches to the slower but more

accurate luminosity channel (Dupuis-Roy et al., 2009).

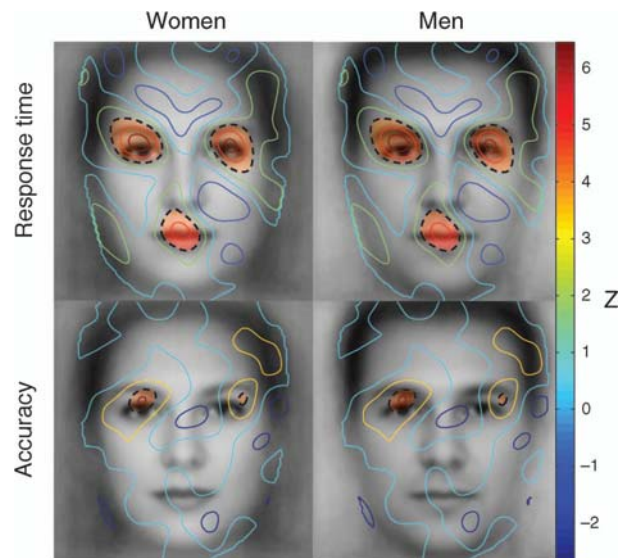
Skin color seems more crucial to gender recognition than other features, including face shape (Bruce & Langton, 1994; Hill, Bruce, & Akamatsu, 1995; Russell & Sinha, 2007; Russell et al., 2006; Tarr et al., 2001; Tarr, Rossion, & Doerschner, 2002). When shown a human face, subjects can tell its gender even if the image is blurred and differs only in color (Tarr et al., 2001). This gender cue may explain the similar evolution of female cosmetics in a wide range of culture areas, i.e., women generally seek to lighten their facial color and to increase its contrast with their lip and eye color (Russell, 2003; Russell, 2009; Russell, 2010).

Figure 1. Averaged female face (left) and averaged male face (right) (White American subjects with no makeup).



Note. Female faces are lighter-skinned than male faces, while showing more contrast between facial skin and lips/eyes. **Upper Left:** Average of 22 female faces; **Upper Right:** Average of 22 male faces; **Lower Left:** White pixels are where the female average is lighter than the male average; **Lower Right:** White pixels are where the male average is lighter than the female average (From Russell, 2010).

Figure 2. Averaged female face (left) and averaged male face (right) (French Canadian subjects with no makeup).



Note. The key facial regions for gender recognition, in terms of either response time or accuracy, seem to be where facial skin borders the lips or the eyes (From Dupuis-Roy et al., 2009).

Origins of Male and Female Skin Pigmentation: Interactions between Age and Sex

Lighter Skin as a Mark of Infancy

Humans are born with little skin pigmentation (Grande et al., 1994; Kahlon, 1976; Walsh, 1964). This pallor is striking in dark-skinned populations, who consider it a mark of infancy. In Kenya, newborn infants are often called *mzungu* ('European' in Swahili), and a new mother may ask her neighbors to come and see her *mzungu* (Walentowitz, 2008). Among the Tuareg, children are said to be born "white" because of the freshness and moisture of the womb (Walentowitz, 2008). According to Zahan (1974), the cause is often thought to be a previous spiritual life:

There is a rather widespread concept in Black Africa, according to which human beings, before "coming" into this world, dwell in heaven, where they are white. For, heaven itself is white and all the beings dwelling there are also white. Therefore the whiter a child is at birth, the more splendid it is. In other words, at that particular moment in a person's life, special importance is attached to the whiteness of his colour, which is endowed with exceptional qualities. (Zahan, 1974, p. 385)

Another Africanist makes the same point: "black is thus the color of maturity [...] White on the other hand is a sign of the before-life and the after-life: the African newborn is light-skinned and the color of mourning is white kaolin" (Maertens, 1978, p. 41).

This infant coloration is phylogenetically old. Nonhuman primate infants differ from adults mainly in coat color, but skin color also differs visibly. This is particularly so with langurs, baboons, and macaques, their skin being pink in newborns and almost black in adults. Be it on skin or fur, natal coloration seems to modify adult behavior in the direction of more care-giving and less aggression (Alley, 1980; Blaffer-Hrdy, 2000, pp. 446-448; Jay, 1962).

Lighter Skin as a Mark of Womanhood

After birth, the skin darkens in both sexes until just before puberty, when girls are slightly darker than boys. Both sexes then lighten in color, but the lightening trend is stronger in girls. This trend begins to level off in late adolescence, and the resulting sex difference persists into adulthood although it may fade away after 40 years of age (Frost, 2007; Kahlon, 1976; Kalla, 1973; Mazess, 1967; Mesa, 1983; van den Berghe & Frost, 1986).

This sex difference varies not only by age but also by body site, being greater on body sites where women have thick deposits of subcutaneous fat (buttocks, breasts, hips). Since skin color is usually measured under the arm to minimize tanning, the degree of sexual dimorphism has been systematically underestimated (Frost, 2010, pp. 118-119). This sex difference also varies by population, being greater in populations of medium skin color and smaller in those with very light or very dark skin (Frost, 2007; Madrigal & Kelly, 2007). Finally, men and women differ not only in constitutive pigmentation, i.e., color of untanned skin, but also in tanning capacity. This facultative sex difference was demonstrated by a New Guinea study that measured unexposed skin color on the upper inner arm, exposed skin color on the forearm, and time spent in the sun. Despite identical sun exposure, the men were darker than the women, and more so on exposed skin (Harvey, 1985). The same finding emerged in another New Guinea study, whose author ruled out the possibility that the women were less exposed to the sun: "as in most parts of New Guinea the adult females are responsible for most of the food cultivation and are therefore exposed almost continuously to sunlight" (Walsh, 1964).

Several lines of evidence point to an innate cause. A Japanese twin study concluded that genetic factors were largely responsible for pubertal lightening of female skin (Omoto, 1965). This was also the conclusion of a year-by-

year skin-reflectance study of Tibetan boys and girls at a refugee boarding school who wore the same kind of uniform, had the same activities, and were examined in December and January, when tanning is minimal (Kalla & Tiwari, 1970). A 'digit ratio' study on English subjects found that lighter skin in women correlates with higher levels of prenatal estrogen (Manning, Bundred, & Mather, 2004). A skin-reflectance study on Black Bahamian subjects found that lighter skin in women correlates with thicker subcutaneous fat (Mazess, 1967). Finally, the sex difference in skin color is partly eliminated by castration and ovariectomy, an indication that the sex hormones contribute to this dimorphism not only at a prenatal stage but also later in life (Edwards & Duntley, 1949; Edwards et al., 1941).

This sexual dimorphism has no true antecedents in nonhuman primates. But there is an analogous dimorphism. In seven of the eight primate species where adult males and females differ in coat color, the sex difference results from the female retaining the infant's lighter coloration. Interestingly, five of the seven (63%) are monogamous, even though monogamy prevails in only 18% of all primate species (Blaffer-Hrdy & Hartung, 1979). This apparent infantile mimicry may be a female adaptation to the social environment of monogamy, specifically vulnerability to male neglect (because male provisioning is more necessary) and male aggression (because cohabitation lasts longer and is more continuous). To reduce these risks, the female may mimic key infant features to inhibit aggressive impulses in her mate and to stimulate feelings of care (Blaffer-Hrdy, 2000, pp. 444-451). It is perhaps for similar reasons that much of mammalian sexuality seems to come from infant behaviors, e.g., cuddling, murmuring, nipple sucking, and mouth licking (Wickler, 1973, pp. 163-185).

Function of Women's Lighter Skin

What use is lighter skin for women? There are three hypotheses:

Infantile mimicry? A fairer color is one of several noticeable features that characterize the human infant, others being a 'baby face,' smooth hairless skin, and a higher pitch of voice. As identifiers of a vulnerable life stage, these features eventually acquired the property of making an observer less aggressive and more willing to provide care. Finally, the adult female body adopted them to influence male observers in the same way (Blaffer-Hrdy, 2000, p. 445; Frost, 1988; Guthrie, 1970; van den Berghe & Frost, 1986).

Signal of fecundability? Through a fortuitous interaction between pigmentation and the sex hormones, fairer skin became a means to assess a potential partner's fecundability. Girls lighten in color after puberty and, later, women tend to darken during pregnancy, as well as slightly during the nonfertile phase of the menstrual cycle (Symons, 1995; van den Berghe & Frost, 1986).

Facilitator of vitamin-D production? Natural selection lightened women's skin to increase vitamin-D production, thereby ensuring enough calcium and phosphorus during pregnancy and breastfeeding (Jablonski & Chaplin, 2000).

These three hypotheses are not necessarily incompatible. Once men and women had visibly differentiated in skin color, for whatever reason, this sex difference would have become a mark of sexual identity. Men would have tended to choose female mates with an unambiguously feminine appearance, and women male mates with an unambiguously masculine appearance, thereby accentuating the initial sex difference through sexual selection. At that point, skin color would have become an index of reproductive health, indicating one's respective degree of feminization or masculinization.

This sex difference in skin color remained highly visible in the social environment as long as ethnic differences remained less so. Thus, wherever the visual arts developed, in regions as far apart as Egypt, Japan, and Meso-America, artists gave a lighter complexion to female figures than to male figures (Capart, 1905, pp. 26-27; Eaverly, 1999; Soustelle, 1970, p. 130; Wagatsuma, 1967).

Today, women's lighter complexion has become much less noticeable in an increasingly multiethnic context. Gendering of skin color has also blurred since the 1920s, when women began to embrace the suntanned look (Segrave, 2005). When I surveyed university students in Quebec City about this sex difference, I found that only a quarter of them were aware of its existence (Frost, 1987, pp. 104-109).

Earlier Meanings

Yet our ancestors were very much aware. Before their continent opened up to the world five centuries ago, Europeans described skin color with reference to the complexions they saw among themselves. 'White,' 'brown,' and 'black' corresponded to what we now call light, tan, and dark. Again contrary to current usage, these gradations identified individuals rather than ethnic groups. A white was a lighter-skinned person and a black a darker-skinned one. This way of seeing things persists in family names that once referred to skin-color gradations within a single population, like White, Brown, and Black among the English, Leblanc, Lebrun, and Lenoir among the French, or Weiss, Braun, and Schwartz among the Germans (Frost, 1990).

This narrow spectrum was conducive to gendering of skin color. A woman had to be fairer than average, i.e., 'white' in Europe or East Asia, 'golden' in South-East Asia, and 'red' in sub-Saharan Africa. Despite being normative for women, a fairer skin did not monopolize all erotic male desires. In old European folklore, some desires could target

darker women, i.e., the nut-brown maid of the English, the *braunes* or *schwarzbraunes Mädel* of the Germans, the *brune* of the French, or the *barna kislány* of the Hungarians. This type of eroticism was ardent, but also stormy and short-lived (Carpenter, 1936; Massny, 1937; Vasvari, 1999).

Conversely, a man had to be darker than average, although attitudes on this point were somewhat ambivalent. A man was handsome if fair, but virile and strong if brown. In medieval England, the tenth token of a knight of 'strong Corage' required a 'broun colore in al the body', a quality that many vaunted by adding 'the brown' to their names (Curry 1916, pp. 80-95).

This male/female distinction, as well as the adult/infant distinction, dominated the social meaning of skin color in the earliest human societies, notably hunter-gatherers and simple horticulturalists. Lighter skin thus signified femininity but not higher status among the hunter-gatherers of the Nicobar Islands:

Headmen and their families do not differ from the rest of the community in respect to colour; their position is due to superior intelligence and not to the mere accident of birth [...] the lighter coloured skins are, however, very generally preferred, and I have known a woman who was admiringly described as the "white widow," whose face proved nevertheless to be several shades darker than that of an ordinary Chinaman. (Man, 1889)

This was also the case among horticultural peoples like the Ibo of Nigeria:

From this body of definitely expressed opinion the equation of paleness of complexion with beauty emerges quite clearly. Divergence never occurs on this issue. In assessing the effect of the European standard it should be borne in mind that the Ibo population is almost entirely free from half-castes, and thus there is no gradual transition between the Negro and European stocks. There can therefore be no "passing." Secondly, paler pigmentation has no class

significance. Wealthy Ibo are of all shades of complexion. (Ardener, 1954)

With increasing class stratification came a growing association between lighter skin and higher status. Such "pigmentocracies" arose partly because the socially dominant were generally landowners whose untanned skin visibly set them apart from the peasants, serfs, or slaves who worked the soil. Another reason, no less important, was the tendency of higher-ranking men to marry the prettiest and fairest-skinned women. Over time, this sexual selection would lighten the mean skin color of the upper classes, as in India:

Wealthy landowning families often have a tradition of seeking light-skinned brides among poorer members of their subcaste. It is very common to find a high concentration of lighter-skinned people among established land-owning families. (Béteille, 1967)

This also seems to have been true in Japan. A study of unexposed skin showed that upper-class Japanese were less pigmented than lower-class Japanese, even when the latter worked indoors in factories and not outdoors on farms. The likeliest explanation is that the upper-class men had a wider range of prospective brides and could thus select the fairest ones, for "skin color has long been regarded, by the Japanese, as one of the criteria for evaluating physical attractiveness, especially in young females" (Hulse, 1967).

Sexual Attraction and Other Tasks

Gender recognition is not the only mental task that involves observing a person's facial skin and measuring its hue and luminosity. There is also sexual attraction, although this task involves many non-visual inputs (hormonal state, personal history, social and physical context, nature of the sexual relationship, etc.). The sex hormones in particular seem to exert an interacting influence, at least on women. This

was the finding of a study where young women were presented with pairs of facial photos: three pairs of female faces and three pairs of male faces. Each pair was identical except for a slight difference in skin luminosity, and the female participant had to choose the face she liked the most. The choices, as it turned out, varied with the phase of the menstrual cycle. The darker male face was more strongly preferred by participants in the first two-thirds of the cycle (when estrogen levels are high in relation to progesterone levels) than by those in the last third (when estrogen levels are low in relation to progesterone levels). Menstrual cycle phase did not affect face preference if the two faces were female or if the participants were taking oral contraceptives (Frost, 1994).

A similar cyclical effect modulates sexual attraction to other secondary sexual characteristics, like face shape and body odor. Although women generally prefer men with a more feminine face shape, i.e., smaller nose and less protuberant chin, this preference reverses during the nine days before ovulation (between days 5 and 14 of a 28-day cycle) when estrogen is at its highest and progesterone at its lowest (Danel & Pawlowski, 2006; Johnston et al., 2001). Women likewise lose their dislike for the smell of androstenone, the main component of male body odor, between days 6 and 14 of the menstrual cycle (Grammer, 1993).

Skin color may also influence the way an observer assesses certain personal qualities. This phenomenon has particularly interested researchers in child development, their aim almost always being to understand how children learn race prejudice. One exception is a research team led by two American psychologists, Deborah Best and John Williams, who argue that all humans have an early developing tendency to prefer lighter skin. They came to this conclusion after studying young European or Japanese children who were unfamiliar with darker-colored ethnic groups. When shown pictures of people or

animals, the children associated lighter skin with positive words, i.e., 'clean', 'pretty', and 'nice', and darker skin with negative words, i.e., 'dirty', 'ugly', and 'nasty' (Best, Field, & Williams, 1976; Best, Naylor, & Williams, 1975; Iwawaki et al., 1978; Munitz, Priel, & Henik, 1987). These associations were not acquired progressively with increasing age, i.e., on a learning curve (Best, Naylor, & Williams, 1975; Munitz, Priel, & Henik, 1987). Nor did the rate of acquisition correlate with the child's IQ, as would be the case if the associations were learned (Williams, Boswell, & Best, 1975; Williams et al., 1975; Williams & Rousseau, 1971).

But does lighter skin necessarily evoke positive qualities and darker skin negative qualities? When a translation error resulted in the children being given the word 'robust', they associated this positive quality with darker skin (Best, Naylor, & Williams, 1975). It appears that the researchers had unwittingly chosen words that evoke not only positive or negative qualities but also feminine or masculine ones.

Conclusion

These different studies point to the existence of a mental module that serves not only to recognize the human face but also to identify its gender by means of sexually dimorphic features, particularly the hue and luminosity of facial skin. This module seems to operate differently in men and women under the influence of hormonal inputs, i.e., the body's ratio of estrogens to anti-estrogens (androgens or progesterone). In addition to assisting gender recognition, the resulting output may also alter the observer's mental state in a number of areas, ranging from sexual attraction to emotional distancing.

Face recognition has recently been studied by a team of Chinese researchers, who concluded that it takes place within a distinct heritable module of the brain and is not simply an aspect of general mental ability (Zhu et al., 2009). This

was a major study with many participants but it proved in several months what had been suspected for several decades. The same approach may show whether this module also processes visual information on the skin's hue and luminosity.

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Peter Frost, Ph.D., graduated from Université Laval in 1995 with a doctorate in Anthropology. Since then, Dr. Frost has been working as a contractor for an indigenous people research group, previously named the *Groupe D'Études Inuit et Circumpolaires (GÉTIC)* and now named the *Centre Interuniversitaire D'Études et de Recherches Autochtones (CIERA)*. His work for them has included translations and revisions of academic papers, as well as a literature review on Labrador Inuit genetics. Peter Frost has recently published *Femmes Claires, Hommes Foncés. Les Racines Oubliées du Colorisme* (Presses de l'Université Laval).

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Open Peer Commentaries

Commentary on Steklis & Steklis (2011): *Graduate Interdisciplinary Programs for Training Students in Human Behavior, Evolution, and Development*

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The most direct way to begin this comment is by responding to the questions posed by H. Dieter Steklis and Netzin G. Steklis (2011; hereafter S&S) at the end of their article.

- I *hope* that the advances described in the paper, especially regarding epigenetics of behavior, will allow new multidisciplinary initiatives. The examples lie outside my expertise, but it seems we are faced with the happy prospect of answering a new set of research questions using new theory and techniques.
- A formalized Graduate Interdisciplinary Program (GIDP) is certainly worth a try.
- Being the recipient of a cross-disciplinary doctorate (in political ethology) 20 years ago it is my experience that GIDP graduates will find it difficult to find placement in traditional departments. The same applies to many students who specialize in human ethology. Where are the jobs for them? I recommend making the negotiation of opportunities for graduates an integral part of the project.
- Regarding the name of the program, it might well be that a neologism will fare better than "human ethology", at least for a while. However, there are costs associated with abandoning that name, mainly resulting from