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Why Cosmetics Work

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1. Cosmetics and beauty

The power of cosmetics

Decorating the face and body is an activity that is among the oldest, most widespread, and persistent of human behaviors. Paint pigments have been found in archeological contexts over 75,000 years old, indicating that people may have decorated themselves with body paint before they covered their bodies with clothing (Jablonski, 2006). The practice has continued since, and people in all societies decorate the face and body. In his cross-cultural description of the decoration of the human body, Robert Brain marvels that "body decoration in some societies is the most important of the arts, and in many cases may justly be termed a fine art. However, for myself as an anthropologist, the most interesting fact to have emerged from researching and writing this book is that the transformation through art of the human body is a basic need which is universally practiced among the peoples of the world, even the most puritanical or the most simple." (Brain, 1979, p.185)

Cosmetic practices are as difficult to eradicate as they are widespread. During the Victorian era in the English speaking world, the use of cosmetics was strongly discouraged, and viewed as morally unsound. Nevertheless, women found ways to change the apparent coloration of their face, using techniques such as pinching their cheeks and biting their lips to create a rosy hue, and wearing colors in their bonnet linings to produce the optical effect of lightening their skin (Peiss, 1998). More recently, attempts in communist countries to ban cosmetics were unsuccessful because they resulted in a black market (Brain, 1979). In the most industrialized societies of the current era, cosmetics are neither discouraged nor banned, and their use is widespread. In 2007 the worldwide retail value of color cosmetics alone[1] was more than $37 billion (source: ©Euromonitor International).

Cosmetics and other decorations of the body are widespread and persistent because they are a part of how what defines us as individuals and as humans. Cosmetics help to give us our identity, and people cling to them in even the most extreme of circumstances. Nancy Etcoff argues that the fashion designer Betsey Johnson's statement "If I were dying, I would be in the hospital wearing lipstick", expressed a timeless sentiment, as evidenced by the pots of red iron oxide for the lips left in ancient Sumerian and Egyptian tombs (Etcoff, 1999). Lieutenant Colonel Mervin Willett Gonin, who was in the British Army unit that liberated the concentration camp Bergen-Belsen in 1945 wrote "It was shortly after the B.R.C.S. teams arrived, though it may have no connection, that a very large quantity of lipstick arrived. This was not at all what we men wanted, we were screaming for hundreds and thousands of other things and I don't know who asked for lipstick. I wish so much that I could discover who did it, it was the action of genius, sheer unadulterated brilliance. I believe nothing did more for those internees than the lipstick. Women lay in bed with no sheets and no nightie but with scarlet lips, you saw

[1] 'Color cosmetics' refers to products intended to alter the user's appearance, and is what is typically meant by colloquial use of the term 'make-up'. For example, this would include lipstick and eyeliner, but not soap, moisturizer or perfume. 'Cosmetics' can refer to all these products and more. The 2007 worldwide retail value of all cosmetics and toiletries was more than $290 billion (source: ©Euromonitor International).

them wandering about with nothing but a blanket over their shoulders, but with scarlet lips. I saw a woman dead on the post mortem table and clutched in her hand was a piece of lipstick. Do you see what I mean? At last someone had done something to make them individuals again, they were someone, no longer merely the number tattooed on the arm. At last they could take an interest in their appearance. That lipstick started to give them back their humanity." (Gonin, 1945, final page)

A universal practice with parochial forms

Charles Darwin argued that the practices of personal decoration found among all different peoples of the world was an argument for the unity of the human race "They rather indicate the close similarity of the mind of man, to whatever race he may belong, in the same manner as the almost universal habits of dancing, masquerading, and making rude pictures." (Darwin, 1871, Ch. XIX, p.339) However, in the same text, he also wrote that "Savages at the present day everywhere deck themselves with plumes, necklaces, armlets, earrings, &c. They paint themselves in the most diversified manner.", (Ch. XIX, p.343) These two observations illustrate the paradoxical nature of personal decoration: it is a timeless and universal human pursuit, but there is immense variety in the specific ways in which it is performed. This situation was not confined to the Darwin's era, and anthropologists continue to record an immense diversity of the forms that cosmetic decoration can take. From the toes to the scalp, every part of the body is painted, tattooed, scarred, or ornamented by one culture or another, in a dazzling variety of styles (Brain, 1979; Ebin, 1979). Even within a given culture, cosmetic practices change rapidly, as they are a primary object of fashion. There can even be multiple, conflicting fashions in the same culture at the same time. In the 1990's, two of the most popular lines of cosmetics in the United States were M.A.C. (which had a bold, theatrical style and a famous drag queen as its spokesmodel) and Bobbi Brown (which had a minimal, natural style and sold 10 different neutral shades of lipstick) (Berg, 2001).

Though the practice of personal decoration is a human universal, the *forms* that these practices impart on the body are diverse. There seem to be few if any universal preferences for particular styles. Given that fashions change and cultural variation is enormous, it would seem that there is no place for a scientific approach to understanding cosmetics. Perhaps for this reason, scientists have not taken significant interest in studying cosmetics. However, science has taken an intense interest in the question of whether there are consistent factors that result in particular faces being considered more or less attractive.

Universal beauty

In the past several decades, the social, evolutionary, developmental, and perceptual psychology communities have taken up the study of facial attractiveness. An important conceptual shift occurred during this period, with researchers moving from the belief that notions of beauty are arbitrary cultural conventions, to the belief there exist biologically based universal factors influencing perceptions of attractiveness (Etcoff, 1999; Fink & Neave, 2005; Langlois et al., 2000; Little & Perrett, this volume; Rhodes, 2006; Thornhill & Gangestad, 1999; Zebrowitz, 1997). The main evidence for the idea that attractiveness has some basis in biology are the observations of agreement between adults in different cultures (Cunningham, Roberts, Barbee, Druen, & Wu, 1995; D. M.

Jones & Hill, 1993; Langlois et al., 2000) and between adults and very young infants (who are too young to have learned cultural standards) (Langlois et al., 1987; Samuels & Ewy, 1985; Slater et al., 1998) on the relative attractiveness of different faces. Together, these lines of evidence suggest that there is at least some agreement on facial attractiveness that is not culturally or socially determined, and hence is biological in origin.

A consequence of the belief in universal agreement on attractiveness is that it has become more meaningful to consider the question "what is considered attractive?" There are now considered to be several reasonably consistent factors of facial attractiveness, including youthfulness (Zebrowitz, Olson, & Hoffman, 1993), skin homogeneity (Fink, Grammer, & Thornhill, 2001), averageness (similarity of the face to the population average) (Langlois & Roggman, 1990), sexual dimorphism (masculinity or femininity) (Cunningham, 1986; Perrett et al., 1998), and bilateral symmetry of the face (Thornhill & Gangestad, 1993). However, none of these factors alone is either sufficient or necessary for a face to be attractive (Zebrowitz & Rhodes, 2002).

The paradox of cosmetics

Given that universal preferences for beauty exist and are structured around biologically based factors of attractiveness, there should also be universal approaches to practices of personal decoration. If there is agreement on what is attractive in a face, there should also be agreement on how the attractiveness of a face can be enhanced. Yet the beautification practices used by the full range of human societies are incredibly varied.

This chapter addresses the question of whether personal decoration practices are arbitrary or follow discernable rules. The primary focus of investigation is the practice of color cosmetics (make-up). I begin by demonstrating the existence of a sex difference in facial contrast, then present evidence that cosmetics are used in precisely the correct way to exaggerate this sex difference, making the face appear more feminine, and hence attractive. I then describe ways in which cosmetics are used to manipulate other factors of beauty in addition to sexual dimorphism. I propose that cosmetics can be viewed as a kind of technology for manipulating these universal factors of facial attractiveness. Finally I discuss how this account of cosmetics may relate to personal decoration in general.

2. Exaggeration of sex differences by cosmetics

Sex differences in pigmentation

As described above, sex differences in facial appearance play an important role in facial attractiveness. However, there is not at present a complete understanding of how male and female faces differ in their appearance. Sex differences in the shape of the face have been well described using traditional caliper-based anthropometric methods (Enlow, 1990; Farkas & Munro, 1987), photographic methods (Burton, Bruce, & Dench, 1993), and laser-scanning methods (Bruce et al., 1993; Burton, Bruce, & Dench, 1993). The differences between male and female facial pigmentation are less well characterized, despite the fact that pigmentation (i.e. surface reflectance properties) is known to be

important for sex classification (Bruce & Langton, 1994; Hill, Bruce, & Akamatsu, 1995; O'Toole et al., 1998; O'Toole, Vetter, Troje, & Bulthoff, 1997).

Known sex differences in pigmentation are limited to differences in the overall brightness and hue of the skin. Female skin is lighter than male skin, a sex difference that has been consistently found in human populations around the world (reviewed by Frost, 1988; Jablonski & Chaplin, 2000). Peter Frost has also provided historical and archeological evidence that this sex difference is well known to ethnically homogenous populations, for whom it is the primary source of skin color variation (Frost, 2005). Female skin is also more green than male skin, which is more red in appearance (Edwards & Duntley, 1939). This is likely due to males having higher concentrations of hemoglobin[2]. This difference is perceptible, and can be used to classify faces by sex (Tarr, Kersten, Cheng, & Rossion, 2001). Little is known about whether and how male and female facial skin differs beyond these "one-dimensional" differences in overall brightness or redness. For example, are the sex differences in pigmentation consistent across different parts of the face?

An agnostic approach toward determining whether there are spatially organized sex differences in pigmentation is to compare the morphed averages of photographs of many male faces and many female faces taken under controlled lighting conditions. Toward this end, I averaged together 22 female and 22 male Caucasian faces. I then warped these two averages into the same androgynous shape, so that all the features were in the same locations. This produced two images in which the outline of the face and the contours of the internal features were spatially registered. These two images are shown on the left of Figure 1. The locations of all the features in these two images are the same, and yet the top left image appears female, and the bottom left image appears male. That the two faces appear male or female despite having the same shapes indicates that pigmentation alone can drive sex classification. However, the specific nature of the differences in pigmentation is not immediately apparent.

[2] Variations in hemoglobin, including transitory within-individual changes, are visible through even the darkest skin. It has been hypothesized that color vision in primates evolved in order to perceive these fluctuations in hemoglobin concentrations of the blood (Changizi, Zhang, & Shimojo, 2006; Changizi & Shimojo, this volume).

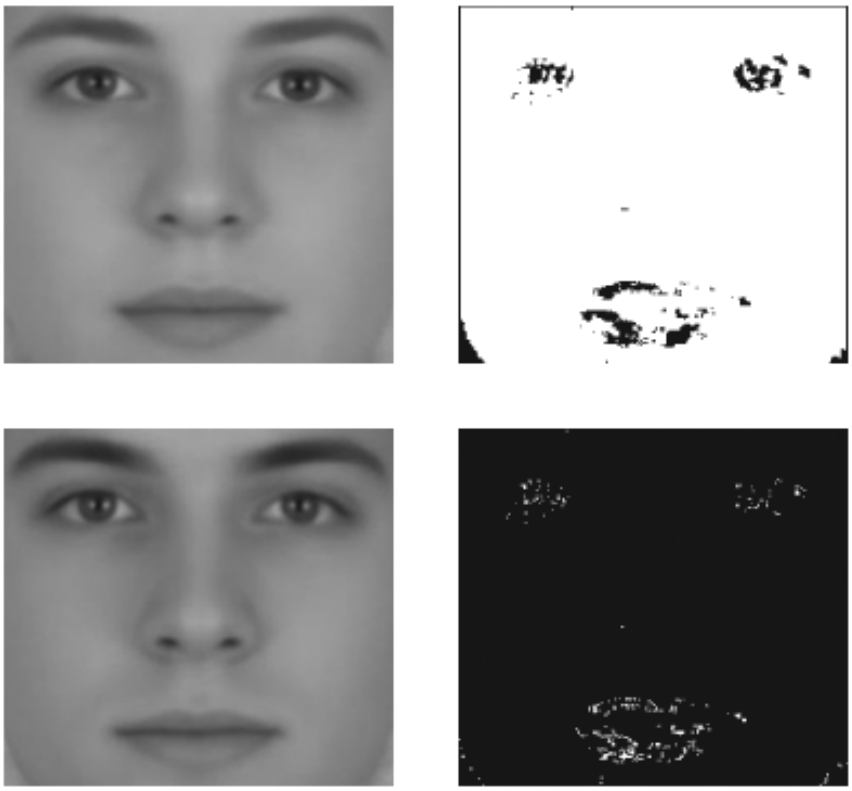

Figure 1. The upper left image was produced by morphing together 22 Caucasian female faces, then warping the averaged image into an androgynous shape. The lower left image was produced by morphing together 22 Caucasian male faces, then warping the averaged image into the same androgynous shape as the female averaged face, above. In the upper right image, white pixels correspond to regions of the female average that are lighter than the male average. In the lower right image, white pixels correspond to regions of the male average that are lighter than the female average.

To explore the differences between the two images, we can subtract one from the other to see which regions of the face are darker or lighter in one sex than the other. The two images on the right of Figure 11 show which pixels are lighter in the female or male averages. In the top right image the white pixels indicate regions in which the female average is lighter than the male average. In the bottom right image the white pixels indicate regions in which the male average is lighter than the female average. Consistent with the literature showing that female skin is lighter than male skin, the female average is lighter in all parts of the face outside of the eyes and lips. However, in the regions of the eyes and lips, some pixels are lighter in the female average, while others are lighter in the male average. All the pixels which are equally light in the two images are found in the eyes and lips (not shown). This suggests that while the skin of the female average is lighter than that of the male average, the eyes and lips of the male and female averages are about equally dark.

A sex difference in facial contrast

If female skin is lighter than male skin, but female eyes and lips are not lighter than male eyes and lips, there should be greater luminance contrast surrounding female eyes and lips than male eyes and lips. This would be important, because the visual system is sensitive to contrast rather than to absolute luminance differences. Indeed,

luminance contrast is the cue to which most neurons in the early visual cortex respond. Moreover, contrast internal to the face would be robust to changes in illumination. The black ink of this text under direct mid-day sun reflects more light than does the white page under dim indoor lighting, yet in both contexts the text appears black and the page appears white because the contrast between the two is constant. In the same way, a sex difference in contrast could be a particularly robust cue for sex classification. If there is a sex difference in contrast it would also mean that the femaleness of the face could be increased by lightening the skin or by darkening the eyes and lips—either change would increase the contrast.

To determine whether there exists a sex difference in luminance contrast between the eyes and lips and the rest of the face—which I term 'facial contrast'—I photographed sets of males and females (Russell, 2009). These sets consisted of 118 clean-shaven and cosmetics-free MIT students, including 51 East Asians and 67 Caucasians. The photos were taken under standardized lighting conditions in order to avoid systematic differences in illumination.

Grayscale versions of each image were individually hand labeled to define regions corresponding to the eyes (including the skin between the epicanthal fold and the eye, and the skin immediately below the eye), the lips, annuli surrounding the eyes (with the approximate width of the eyes but not including the eyebrow), and an annulus surrounding the lips (with the approximate width of the mouth). The definition of these regions is illustrated in Figure 2. Illustration of feature labeling. Solid lines demonstrate how the boundaries of the eyes and lips were defined. Dashed lines indicate how the boundaries of the annuli surrounding those features were defined.. The luminance values of all pixels within the eyes were averaged, as were all the pixels in the lips, the annuli surrounding the eyes, and the annulus surrounding the lips. This yielded mean luminance values for each of the four regions (eyes, skin surrounding eyes, lips, skin surrounding lips). Mean luminance values for the eyes and lips were averaged to produce the mean feature luminance. Similarly, mean luminance values for the eye annuli and lip annulus were averaged to produce the mean skin luminance. Skin and feature luminance, both being the averages of 8-bit pixel values, could range from 0 (black) to 255 (white). Facial contrast was calculated as C_F = (feature luminance – skin luminance) / (feature luminance + skin luminance). This is a kind of Michelson contrast, which varies from 0 to 1, with higher values indicating greater contrast, and 0 indicating no contrast.

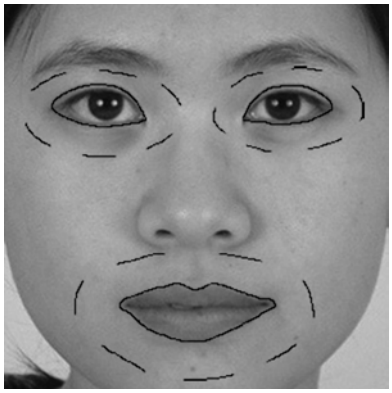

Figure 2. Illustration of feature labeling. Solid lines demonstrate how the boundaries of the eyes and lips were defined. Dashed lines indicate how the boundaries of the annuli surrounding those features were defined.

In both the East Asian and Caucasian samples, the female faces had greater facial contrast than male faces. The East Asian faces (with dark eyes) had greater facial contrast than the Caucasian faces (with lighter eyes), but the sex difference in facial contrast did not differ between East Asian and Caucasian faces. Contrast around the eyes or mouth alone can also be calculated, with eye contrast as C_E = (eye luminance – eye skin luminance) / (eye luminance + eye skin luminance) and mouth contrast as C_M = (mouth luminance – mouth skin luminance) / (mouth luminance + mouth skin luminance). Females had greater eye contrast than males in both the East Asian and Caucasian samples. The East Asians (with dark eyes) had much greater eye contrast than the Caucasians (with lighter eyes), but the sex difference was the same in both ethnic groups. There was also a sex difference in the mouth contrast, but it was almost non-existent for the East Asian faces. Of the two features, the sex difference in contrast was larger for the eyes than the mouth, particularly for East Asians.

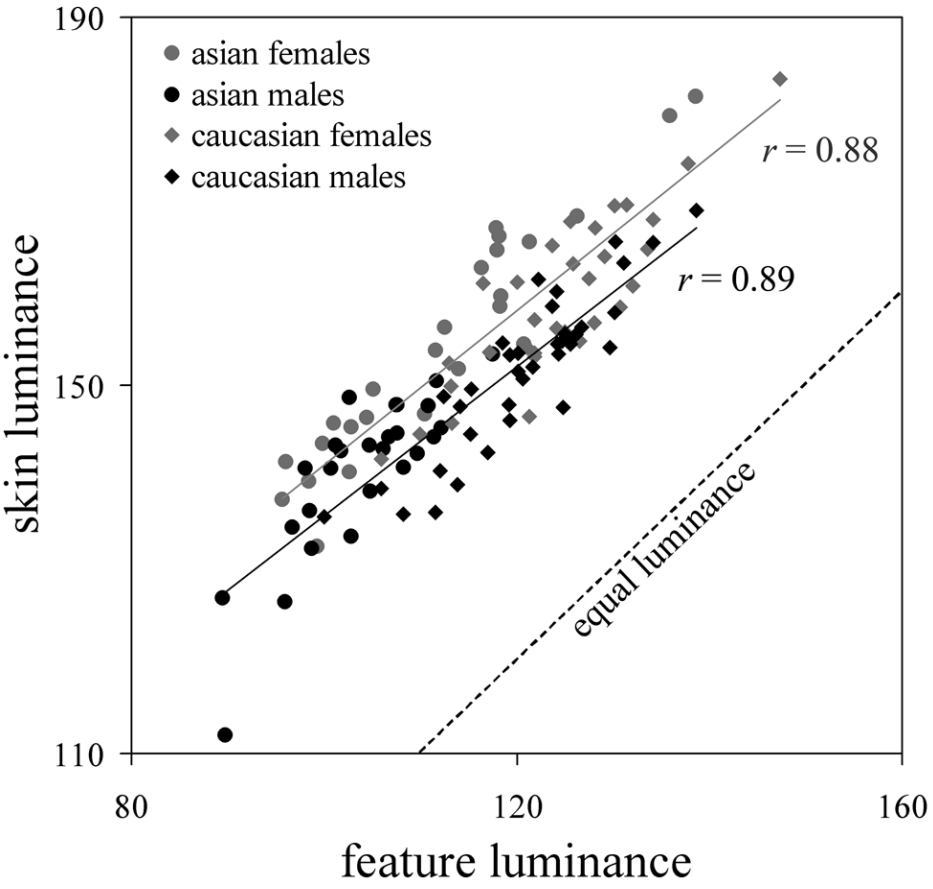

Figure 3. Skin luminance plotted against feature luminance, with each point representing a single face image. Larger values on either axis indicate brighter regions. The regression line for female faces is above that for the male faces, due to female faces having lighter skin than male faces. Female eyes and lips are also lighter, but to a much smaller degree.

Figure 3 shows skin luminance plotted against eye and lip (feature) luminance for each face. The sex difference in facial contrast can be appreciated by noting that the

regression line for female faces lies further from the line of equal luminance (along which the skin and features are equally dark) than does the regression line for male faces. Female skin was lighter than male skin. Female eyes and lips were also lighter than male eyes and lips, but the difference was much smaller than the difference between male and female skin. The sex difference in facial contrast is a result of the sex difference in feature (eye and lip) luminance being much smaller than the sex difference in skin luminance.

Although the lighting was diffuse and standardized across faces, a potential concern is that this sex difference in facial contrast could be caused by a sex difference in the shape of the face. Light reflected by a surface is a product not only of the illumination and reflectance properties of the surface, but also of the three-dimensional shape of the surface. In the context of facial contrast, the concern is that eyes and lips that recede more from the facial surface will appear darker than eyes and lips that recede less from the facial surface. However, male eyes recede more than female eyes, and male brows are more protuberant than female brows (lip protuberance does not differ between the sexes) (Bruce et al., 1993). This means that sex differences in face shape may actually *reduce* the apparent sex difference in eye contrast, because male eyes are further recessed and shaded by the brow, which may result in less illumination falling on male eyes than female eyes.

It is unclear why the sex difference in eye and lip reflectance is smaller than the sex difference for the skin more generally. A recent account of the evolution of skin pigmentation (Jablonski & Chaplin, 2000) may suggest a possible answer. This account argues that the amount of melanin in the skin represents a compromise between the costs and benefits of exposure to solar UV radiation. Melanin regulates the penetration of UV radiation into the skin; darker skin with more melanin permits less UV radiation. There are several dangers of UV exposure; the benefit is that it leads to the synthesis of vitamin D_3, which enhances calcium absorption. According to this account, natural selection has resulted in females having lighter skin and increased vitamin D_3 production to meet the greater calcium needs of pregnancy and lactation. This account does not discuss eye and lip pigmentation, and it is possible that there is a different balance between costs and benefits of UV exposure in the eyes and lips than in the rest of the skin. These features (particularly the eyes) have greater sensitivity to light, yet cannot significantly contribute to vitamin D_3 production because they form a miniscule portion of the body area exposed to the sun. Thus, it may be that female eyes and lips are not much lighter than male eyes and lips because they are too small to play a significant role in vitamin D_3 production, but could be damaged by greater UV exposure.

There was not a significant correlation between skin tone and facial contrast when sex and race were included as control variables. This indicates that facial contrast is not a simple function of skin tone, which suggests that the sex difference in facial contrast should also exist in ethnic groups with darker skin. However, this relationship may not extrapolate, and since only Caucasian and East Asian faces were actually measured it cannot be stated with certainty that the sex difference in facial contrast will generalize to other ethnic groups. This represents an important avenue for further research.

Perceptual relevance of facial contrast

Though luminance contrast is a robust visual cue, the effect size of the sex difference in facial contrast (d = 0.55 for East Asians and d = 0.60 for Caucasians) is much smaller than effect sizes for well known sexual dimorphisms such as waist-to-hip ratio (d = 1.7, ((Dobbelsteyn, Joffres, MacLean, & Flowerdew, 2001)). The smaller effect size is likely the reason why people are not aware of the sex difference in facial contrast, while they are aware of the sex difference in waist-to-hip ratio. Though people are not conscious of the sex difference in facial contrast, they may nevertheless use it as a cue in making judgments of facial masculinity or femininity and to determine the sex of a face.

In order to determine whether the magnitude of facial contrast is related to judgments of masculinity and femininity, we had 29 subjects (15 female) give Likert scale ratings of masculinity (for male faces) or femininity (for female faces) to the images described above. Facial contrast was positively correlated with rated femininity of female faces but negatively correlated with rated masculinity of male faces. After controlling for skin luminance (which is also sexually dimorphic) and ethnicity (there were both Caucasian and East Asian faces), facial contrast was still positively correlated with rated femininity of female faces and negatively correlated with rated masculinity of male faces, though the relationship was very weak for male faces. In summary, greater facial contrast was considered more feminine in female faces and less masculine in male faces. This effect was also found when looking at eye contrast or mouth contrast alone.

Figure 4. The Illusion of Sex. The left face appears male, while the right face appears female, yet both images were produced by making slight alterations of the same original image. The eyes and lips were unchanged, and hence equally dark in both images. The remainder of the image was darkened in the left image, and lightened in the right image. The eyes and lips may appear darker in the right than the left image, but are not—it is an example of simultaneous contrast.

The ability of facial contrast to determine the apparent sex of a face is demonstrated in Figure 4. Both images were created by manipulating the same original image—a perceptually androgynous face that was made by morphing together male and female average faces. To make both images, the eyes and lips were left unchanged, but the rest of the image was darkened to produce the left image, and lightened to produce the right image. Because the eyes and lips were unchanged while the rest of the face was made darker or lighter, facial contrast was decreased or increased. Though a subtle manipulation, it has a powerful effect—making the image with decreased contrast appear

male and the image with increased contrast appear female. A similar effect is achieved if facial contrast is manipulated by darkening or lightening the eyes and lips but keeping the rest of the face unchanged (Russell, 2009, Figure 4). However, darkening or lightening the entire face (leaving facial contrast unchanged) has no effect on perceived gender (Russell, 2009, Figure A2), indicating that it is the magnitude of the facial contrast and not the overall lightness or darkness of the face that affects the apparent gender. Though people are not consciously aware of the sex difference in facial contrast, this illusion demonstrates that they nevertheless use facial contrast as a cue in perceiving the sex of a face.

Relevance of facial contrast to attractiveness

Of the factors of facial attractiveness, sexual dimorphism is among the most important but also one of the most complex (Rhodes, 2006). For female faces, the relationship between attractiveness and femininity is straightforward. Evidence from many studies using a variety of methods supports the notion that more feminine female faces are considered more attractive. However, for males there is conflicting evidence whether a more or less masculine face is considered attractive, and there are systematic individual differences in preference for masculine or feminine faces (Little & Perrett this volume). Setting aside the individual differences, the best evidence currently supports a weak but positive relationship between masculinity and attractiveness, as found by a recent meta-analysis (Rhodes, 2006). Regardless, it is undisputed that femininity is much more attractive in female faces than in male faces.

Because facial contrast is sexually dimorphic, and there is a relationship between sexual dimorphism and facial attractiveness, we might expect to find some relationship between facial contrast and facial attractiveness. In an earlier study, I investigated this question by manipulating the facial contrast of male and female faces, and having subjects rate the faces for attractiveness (Russell, 2003). Whether contrast was manipulated by changing the darkness of the eyes and lips while keeping the rest of the face constant (Experiment 1), or by keeping the eyes and lips constant while changing the darkness of the rest of the face (Experiment 2), the manipulation had opposite effects on male and female faces. Example stimuli from Experiment 1 of Russell (2003) are presented here in Figure 5. However, changing the darkness of the *entire* face had no effect on ratings of male or female attractiveness (Experiment 4), indicating that it is not the overall darkness of the face, but the magnitude of the facial contrast that affects the perceived attractiveness.

Figure 5. Examples of female (top row) and male (bottom row) stimuli from Experiment 1 of Russell (2003). Faces in the middle column are original photos that have not been manipulated. Faces in the left column have had the eyes and lips lightened, while the rest of the face remains constant. Faces in the right column have had the eyes and lips darkened, while the rest of the face remains constant. Female faces with greater facial contrast were rated more attractive than those with lesser facial contrast, while the opposite was found with the male faces.

Received cosmetics

Before specifically discussing how facial contrast relates to cosmetic use, let us first consider how cosmetics are used. One approach toward understanding how cosmetics are used is to compare 'before and after' images (i.e. a photograph taken 'before' cosmetics have been applied paired with another taken 'after' cosmetics have been applied), as illustrated in Figure 6. On the left is the morphed average of 12 Caucasian females (18-21 years, mean 19.6 years) photographed under controlled lighting conditions wearing no cosmetics. On the right is the morphed average of the same 12 females photographed under the same lighting conditions wearing cosmetics that they applied themselves, with the instruction to "apply cosmetics as you would when going out at night". The most obvious difference between the two images is the darkening of the eyes and lips in the image of the faces with cosmetics. This is not surprising—lipstick and eyeliner are among the most commonly used cosmetics.

Figure 6. Averages of the same 12 females wearing no cosmetics (left) and wearing cosmetics as they would "when going out at night".

The general style of cosmetics seen in Figure 6 will be familiar to the readers of this chapter. The primary constituents of this style are: eyeliner, eye-shadow, and mascara for darkening the eyes and lashes, lipstick for darkening the lips, blush for making the cheeks pink, and foundation for making the skin tone more even, and sometimes lighter[3]. I call this the 'received style' of cosmetics, or simply 'received cosmetics', to indicate the common or generally accepted use of this style in industrialized societies.

Why do received cosmetics exist in the form that they do? Why are the eyes and lips darkened instead of the nose and eyebrows? And why are they darkened and not lightened? Of the hundreds of possible patterns of modification by color cosmetics, why was this pattern chosen? It should be clear by now that this pattern of cosmetic use is almost certainly not accidental; that it precisely exaggerates the sex difference in facial contrast.

Exaggeration of facial contrast by cosmetics

The received style of cosmetics involves darkening the eyes and lips while leaving the rest of the face largely unchanged. This is one of two patterns of cosmetic application that could increase facial contrast (the other being to significantly lighten the entire face, except for the eyes and lips). To confirm that cosmetic application increases facial contrast, we measured the facial contrast of the set of 12 Caucasian faces that were photographed with and without cosmetics (Russell 2009). On average, facial contrast was much larger with cosmetics than without cosmetics, and greater facial contrast was found in each of the 12 faces when they were wearing cosmetics than when they were not. Both eye contrast and mouth contrast were increased by cosmetics. The large and consistent increase in facial contrast achieved with cosmetics more clearly differentiates male and female faces. The effect size of the sex difference in facial contrast comparing the 36 male Caucasian faces and the 12 female Caucasian faces wearing cosmetics, d = 1.85, is similar to the effect size of the sex differences in waist-to-hip ratio.

[3] Though it reflects the vision of a particular make-up artist, the book Makeup Your Mind by François Nars (Nars, 2001) is an excellent resource for understanding how cosmetics affect the appearance of the face. It contains tightly controlled 'before' and 'after' images on facing pages with clear plastic overlays to indicate the specific cosmetics applied to different parts of the face in the 'after' images.

Application of cosmetics increases facial contrast—precisely the manipulation capable of making the face appear more feminine. It is highly unlikely that this would happen by chance. Different parts of the face could be lightened or darkened in many ways, but only this particular pattern is related to how male and female faces differ. Moreover, there is a direction to the pattern—increasing the contrast makes the face appear more feminine, but decreasing it makes the face appear more masculine. Yet cosmetics are used consistently to increase facial contrast. Faces are rated more feminine when they are wearing cosmetics than when they are not wearing cosmetics (Cox & Glick, 1986), and are also rated more attractive, whether the cosmetics are self-applied (Cash, Dawson, Davis, Bowen, & Galumbeck, 1989) or professionally-applied (Cox & Glick, 1986; Graham & Jouhar, 1980; Huguet, Croizet, & Richetin, 2004; Mulhern, Fieldman, Hussey, Leveque, & Pineau, 2003). Taken together, this suggests that an important function of the received style of cosmetics is to increase the apparent femininity—and hence attractiveness—of the female face by increasing facial contrast.

Cosmetics manipulate biologically-based factors of attractiveness

The use of color cosmetics to increase facial contrast is not the only situation where cosmetics are used to accentuate a sex difference to make the female face appear more feminine and hence more attractive. Another such manipulation of a sexually dimorphic facial feature is eyebrow plucking. Both eyebrow thickness and eyebrow-to-eye distance are sexually dimorphic (Burton, Bruce, & Dench, 1993; Farkas & Munro, 1987), with females having thinner brows that are higher above the eye. Accordingly, these sex differences of the eyebrow are important cues for perceiving the sex of a face (Bruce et al., 1993; Sadr, Jarudi, & Sinha, 2003). Eyebrows are routinely plucked from the bottom rather than the top of the brow (Aucoin, 1997; Brown & Iverson, 1997), resulting in a thinner brow that is also further from the eye, making the face appear more feminine. Thus, trimming the bottom of the eyebrow exaggerates two sexually dimorphic features at once. The exaggeration of sex differences in facial appearance to make the female face appear more feminine and hence more attractive is likely a major principle of cosmetic use, albeit an implicit rather than explicit principle.

As described above, in addition to sexual dimorphism there are several other factors of facial attractiveness, including youthfulness, skin homogeneity, averageness (proximity to the population average), and bilateral symmetry of the face. Several cosmetic practices involve manipulations to make the face appear more youthful, including lip plumping and rhytidectomy (‘face lift’). Among the more common of cosmetic practices are the application of foundation and the covering of blemishes, both of which increase the homogeneity of the appearance of the skin (Mulhern, Fieldman, Hussey, Leveque, & Pineau, 2003), which is known to be related to the perceived age, health, and beauty of a face (Fink, Grammer, & Matts, 2006; Fink, Grammer, & Thornhill, 2001; B. C. Jones, Little, Burt, & Perret, 2004; Matts, Fink, Grammer, & Burquest, 2007). Facial averageness is perhaps the factor of attractiveness that is the least well understood outside the scientific community, and so there are few direct references to practices that aim to increase it. However, popular women’s magazines and other guides to cosmetic practice advise identifying ‘problem features’—typically meaning distinctive or unusual features (e.g. very wide-set eyes or a large nose)—and learning how to make them appear less distinctive. For more sophisticated practitioners,

this may even involve the use of techniques designed to change the apparent shape of the face by acting on the brain's shape-from-shading heuristics for visual perception (Pearl, 2004). Symmetry at the least is generally not violated by cosmetics; it is rare to find a cosmetic technique that involves asymmetric manipulation. The application of foundation also reduces the asymmetry of skin pigmentation (Mulhern, Fieldman, Hussey, Leveque, & Pineau, 2003), and presumably makes the pigmentation appear closer to the population average.

Collectively, these practices indicate that cosmetics are applied in ways that manipulate many of the factors of attractiveness that have been discovered by the scientific community in recent decades. Though cosmetics are used in ways that affect these factors, there is not necessicarily conscious awareness of these factors. With some factors there is explicit knowledge (as in treatments to make the face appear more youthful and the skin tone more homogenous) while with other factors the knowledge is implicit (as in treatments to make the face appear more feminine or more average).

3. Cosmetics as technology

We have seen here that cosmetic use is not arbitrary, but instead follows discernible patterns. In particular, it is organized in such a way as to manipulate known factors of attractiveness. Could this be an accident that cosmetics just happen to be used in such ways as to manipulate these factors of beauty? Though possible, it is extraordinarily improbable. It is even more improbable given that this style of cosmetics developed independently in different locations, as I will describe later in the chapter. This poses a problem for accounts of cosmetics as arbitrary cultural phenomena. However, it is consistent with the notion that the manipulation of these factors of beauty is an integral function of cosmetics.

The idea that cosmetics have the function of manipulating the appearance of the face to affect universal factors of beauty suggests that cosmetics can be viewed as a kind of technology for making the face more attractive. In this account, cosmetics function by manipulating biologically-based factors of attractiveness (including those that have been recently discovered and perhaps other undiscovered factors). The technology consists of applying implicit knowledge of facial attractiveness in order to alter the appearance of the face to make it more attractive to the perceptual systems of other people[4].

Though cosmetics are applied to the face of the wearer, they are designed to operate on the visual system of the perceiver—it is how the face will be perceived that is relevant. For example, darkening the eyes and lips does not make the face more feminine in a physical sense (female eyes and lips are actually slightly lighter than male eyes and lips), but it does increase facial contrast, which makes the face more feminine in a

[4] There is another sense in which cosmetics can be considered a technology. Cosmetic science (or cosmetic chemistry) is an active field of research devoted to advancing the development of cosmetics, toiletries, and perfumery, with its own specialized degrees, societies, and journals. The focus of this field is the development and safety testing of chemicals and materials to be used as cosmetics, and is allied with other branches of chemistry and dermatology. The development of substances for use as cosmetics is unambiguously a technology; however, it is not what I am describing here. The idea of cosmetics as technology that I am describing is focused on the process of choosing how to manipulate the visual appearance of the face. Though there is overlap in these endeavors, they are also easily discernable.

perceptual sense. Thus it is necessary to consider cosmetics in terms of the visual system of the intended perceiver.

Indeed, different people have different visual systems, and different visual experiences. The ability of cosmetics to enhance facial attractiveness is greater for some observers than others, and greater for some groups of observers than others (e.g. psychology students vs. aesthetic (cosmetology) students (Huguet, Croizet, & Richetin, 2004). This may be due to differing attitudes about cosmetics and who wears them. Alternatively (or additionally) it may be due to people having had different visual experiences. Though there is ample evidence for universal agreement on facial attractiveness, this agreement is not complete. There are substantial individual differences in attractiveness preferences (Cornwell et al., 2006; Honekopp, 2006; Little & Perrett, 2002), and attractiveness preferences are socially organized (Bronstad & Russell, 2007) and socially transmitted (B. C. Jones, DeBruine, Little, Burriss, & Feinberg, 2007). Some of the variation in the use of cosmetics may be caused by these individual and group differences in facial attractiveness preferences.

An account of cosmetics as technology need not deny the possibility for functions that cosmetics can play, including stylistic and cultural functions. The application of cosmetics can have a functional or technological goal (making the face more attractive), as well as a stylistic goal. Cosmetics—like houses, clothing, and cars—can be objects of fashion and at the same time have a functional purpose. With their position front and center on the face, cosmetics have the ability to serve multiple functions. They allow for different self-presentations in different contexts. A woman may want to convey competence and maturity while at work during the day, but romantic availability and youthfulness at night. Though the facial qualities associated with these traits are not the same, cosmetics in the hands of a skilled practitioner can be used to emphasize the relevant traits to convey these impressions. More subtly, there is evidence for different *kinds* of beauty (Franklin & Adams, this volume; Zebrowitz & Rhodes, 2002), which may not involve the same factors as beauty for mate selection. Consistent with this idea, cosmetics can be used to emphasize different kinds of 'looks' (Aucoin, 1997). Cosmetics can also communicate where the wearer sees herself fitting into society. This connection between cosmetics and identity will be taken up at length later in this chapter.

From cosmetics to personal decoration

Careful study demonstrates that cosmetic use is not arbitrary, but rather is used to manipulate biologically based factors of beauty. But what about other kinds of personal decoration? Personal decoration in all its forms is much more diverse than received cosmetics, and so contemplating how it works is inherently more speculative. But can we at least formulate a systematic approach to understanding patterns of decoration?

A critical step toward a universal account of personal decoration lies in recognizing that not all styles exist for the purpose of making the wearer appear more attractive. For the present purposes, decoration can be divided into two primary types, 'beautification' and 'signification'. Beautification refers to adornment intended to make the wearer more attractive, without affecting their location within society. Signification refers to adornment that places an individual within society, wherein the specific adornments are signs that stand for something else. In the words of Victoria Ebin, body decorations can amount to "…a statement made by the individual about himself and his

society.", and are "part of a signaling system, communicating information not because of any mechanical link between means and ends, but because of the existence of a culturally defined communication code." (Ebin, 1979, p.10) This kind of adornment can be used to mark the culture, class, religion, or other social group to which a person belongs. It can also be used to indicate status, rank, or wealth within a group, as well as other personal information, such as age, gender, or reproductive status. Adornment can also signal more subtle information, such as rebellion against social norms. Like clothing (Barnard, 1996; Davis, 1992), marks of signification are involved in the *visual representation of identity*, and have enormous scope and range (Brain, 1979; Ebin, 1979).

This classification is not binary; specific decorations may play both beautification and signification roles. A particular hairstyle, item of clothing, or style of cosmetics may signal that the wearer is from a particular cultural group, of a certain age, etc., but also enhance the beauty of the wearer. For example, tattoos and face paint are often used to indicate group identity or social position, but may also be used in ways that manipulate biological beauty factors; there are systematic sex differences in the anatomical locations of scarification and tattooing (Singh & Bronstad, 1997) and symmetrically applied decorations can enhance facial attractiveness (Cárdenas & Harris, 2006). Conversely, lipstick and other cosmetics are often forbidden to girls, and so their use can mark the passage from girlhood to womanhood (Ragas & Kozlowski, 1998). Decoration for signification may also develop beauty connotations via *overgeneralization* (Zebrowitz et al. this volume). For example, a particular decoration may become associated with beauty precisely because it signifies an attractive group such as nubile women or the wealthy or powerful.

The set of possible forms of decoration that could work for signification is much larger than the array of possible forms of decoration that could work for beautification, because the visual constraints on beautification are much stronger than on signification. Any pattern, color, or shape can potentially used as a sign, but only a small set of alterations to the face or body are capable of acting on the biological factors of beauty. For this reason, signification most likely predated beautification as a function of adornment. Decoration for beautification (e.g. cosmetics) may have developed by accident at multiple locations and times when it was noticed that a signifying decoration had the effect of making the wearer more beautiful. Or it may have been an entirely unconscious process. Adornments for signification (or other functional purposes, such as medicinal) that happened to make the wearer more beautiful may have simply been more likely to withstand changes in fashion.

Insofar as adornment or markings for signification have a symbolic nature, their surface forms are inherently arbitrary. In this light it is not surprising that there is diversity in the specific forms that this kind of decoration takes. It would not make sense to look for universal *forms* for signification. Instead, we might expect to find universal *functions* (categories) of signification. For example, most if not all cultures use adornment to communicate marital or mating status. However, this status is conveyed by a wide variety of forms, including tattoos, jewelry, hairstyle, and body painting.

Cultural variation

Returning to the question of why there is so much variation in styles of personal decoration, we can see that much of it can be attributed to adornment for signification.

While there may well be universals regarding the *functions* of this kind decoration, we cannot expect the *forms* to follow rules, beyond that they must be perceptible by the relevant people under the relevant conditions (a sign works only if the intended viewers can see it). Thus, much of the variation in the forms of personal decoration—probably the majority of the variation—does not need to be explained.

Yet even if we restrict ourselves to decoration whose purpose is to make the person more beautiful, there is still significant variation. However, this problem largely disappears when we take the viewpoint that cosmetics are a kind of technology. Technology is not consistently developed across all cultures. It is taken as a given that different cultures have differently developed practices of agriculture, medicine, and communication, for example. Similarly, there is no reason to expect cosmetic practices to be equally developed in all cultures. A reasonable assumption is that the development of cosmetic technology is roughly correlated with the development of other technologies in a given society.

Consistent with the idea that development of cosmetics is associated with other technologies is the evidence that the received style of cosmetics developed in early centers of civilization—the same locations where many other technologies were first developed. Ancient Egypt was an early center for the development of cosmetics (Dayagi-Mendels, 1989). Indeed, the Egyptians "had most of the cosmetic aids which have ever been devised" (Corson, 1972, p.8), including rouge for the lips and cheeks, eyeliner (kohl), eyeshadows, and foundation, all of which were produced by professional cosmetics makers. The painted limestone bust of the famously beautiful Queen Nefertiti, attributed to the sculptor Thutmose in the fourteenth century B.C.E., demonstrates cosmetic use that appears strikingly modern (Figure 7). In Mesopotamia, pots of colored paints for the eyes, and rouges for the lips have been found in Sumerian tombs near Ur from 5,000 years ago.

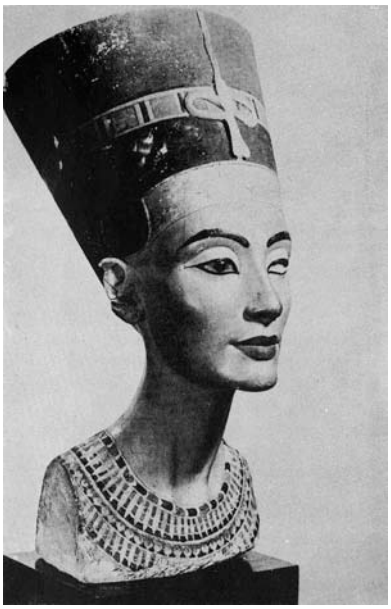

Figure 7. Bust of Nefertiti displayed in Altes Museum in Berlin

However, the received style of cosmetics did not develop in only a single civilization or even adjacent civilizations. Another early center of technological and cosmetic development was the Indus Valley Civilization. Excavations at Harappa and Mohenjo-daro have found kohl pots and sticks for lining the eyes, as well as red iron oxides and white lead-based compounds that have been surmised to be rouge for the lips and cheeks and foundation for lightening the skin (Chandra, 1973; Subbarayappa, 1999). These uses of cosmetics persisted into historical times in the Indian subcontinent, and can be seen in the eleventh century C.E. temple sculpture from the Khajuraho temples in Madhya Pradesh (Figure 8). Evidence for ancient uses of received cosmetics in the East Asia is less clear, though there is a long history of the use of white face paint and rouge for the lips in China and Japan (Corson, 1972). Overall, there is evidence for the idea that the received style of cosmetics developed in multiple centers of early technology development, and spread outward to peripheral areas such as Europe and Southeast Asia, analogous to the spread of other technologies like agriculture and writing.

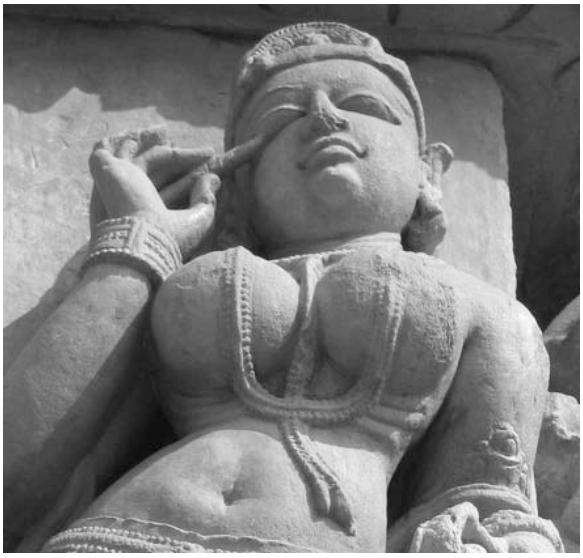

Figure 8. Eleventh century sculpture from Khajuraho temples of a woman applying eyeliner.

As at the present, the early societies who wore the received style of cosmetics would have been relatively wealthy and powerful in comparison with neighboring societies who wore other styles. Wealth and power are always desirable, regardless of other aesthetic considerations. An alternative possibility is that the received cosmetic style spread outward from early technology centers simply because it represented the appearance of the dominant people in the region, and not because it was a more advanced technology for personal decoration. An argument against this alternative possibility comes from the development of cosmetics during Edo (Tokugawa) period Japan (1603-1868). During this period Japan was marked by seclusion, with very limited political, economic and cultural influences from external sources. It was during this time of isolation that witnessed the development of Geisha, whose style of cosmetics has remained unchanged to the present day (Corson, 1972). The cosmetics worn by the Geisha are perhaps the most exaggerated version of received cosmetics. With virtually white skin, black eyeliner, and bright red lips, a Geisha apprentice has exceptionally high facial contrast (Figure 9). That this style developed during a period of extreme isolation

contradicts the notion that use of the received style of cosmetics has expanded only as a result of subordinate groups wishing to look like dominant groups.

Figure 9. Traditional Geisha apprentice cosmetics

The future of cosmetics

A possible critique of this analysis is that it is a new version of the traditional assumption that 'what we do is better than what they do'. Specifically, it could be argued that it is simply an invented justification for why the customs of the author's society are superior to those of other societies. This would be similar to what Elaine Hatfield and Susan Sprecher have named "Finckism", after the Victorian Psychologist Henry Finck, who argued that humankind reached it's pinnacle of attractiveness in the upper-class English gentleman (Finck was such an individual) (Hatfield & Sprecher, 1986). However, the idea presented here of cosmetics as a kind of technology suggests that the received style of cosmetics is itself under-developed.

Technology can be defined as the application of a body of knowledge toward a practical problem. In that sense received cosmetics may best be described as an implicit or primitive technology, because it is applied without explicit knowledge of many of the factors of beauty. Rather, it has developed over a long period of time through trial and error in order to meet the desire of people to appear more attractive. The organizing factors of beauty are only now being discovered, and their systematic application will allow cosmetics to become a technology in the full sense. In this regard, the idea that cosmetics are a kind of technology contains a testable hypothesis—that the effectiveness of cosmetics could be enhanced through the application of scientifically discovered factors of beauty.

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