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Paper:

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Cosmetics Alter Biologically-Based Factors of Beauty: Evidence from Facial Contrast

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Abstract: The use of cosmetics by women seems to consistently increase their attractiveness. What factors of attractiveness do cosmetics alter to achieve this? Facial contrast is a known cue to sexual dimorphism and youth, and cosmetics exaggerate sexual dimorphisms in facial contrast. Here, we demonstrate that the luminance contrast pattern of the eyes and eyebrows is consistently sexually dimorphic across a large sample of faces, with females possessing lower brow contrasts than males, and greater eye contrast than males. Red-green and yellow-blue color contrasts were not found to differ consistently between the sexes. We also show that women use cosmetics not only to exaggerate sexual dimorphisms of brow and eye contrasts, but also to increase contrasts that decline with age. These findings refine the notion of facial contrast, and demonstrate how cosmetics can increase attractiveness by manipulating factors of beauty associated with facial contrast.

Keywords: facial contrast, sexual dimorphism, beauty, cosmetics, skin color

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Introduction

Our faces convey a wealth of information about us, but perhaps the clearest signal from our faces is that of our sex. Male and female faces differ most obviously in terms of shape, following different developmental trajectories under varying hormonal influences (Farkas, 1987). This sexual dimorphism in facial shape is linked to a multitude of biologically important traits, such as health (Thornhill and Gangestad, 2006) and attractiveness (Perrett et al., 1998).

Research into facial sexual dimorphism and how it affects perceptions of attractiveness and mate choice (see Rhodes, 2006, for a review) has focused greatly on facial shape (Thornhill and Gangestad, 2006). However, surface reflectance properties,

such as skin texture, are actually more important than facial shape for perceiving the sex of faces (Hill, Bruce, and Akamatsu, 1995). The properties of the skin, such as color distribution (Samson, Fink, and Matts, 2010) and luminance (Jablonski and Chaplin, 2000), also play a role in the perception of traits related to health and attractiveness (Samson, Fink, and Matts, 2010; Stephen, Coetzee, and Perrett, 2011). There is also a sexual dimorphism in facial coloration - women tend to have lighter skin than men, who are darker and ruddier (Nestor and Tarr, 2008), a difference consistent across different racial and ethnic groups (Frost, 2005).

Aside from global sex differences in skin color, there are cues to sex within the coloration of our faces. Contrast in particular is a vital component of visual perception, as it is the property encoded by the majority of neurons in the primary cortex (Geisler, Albrecht, and Crane, 2007), and its role in evolutionary models of face perception has not been thoroughly studied. Faces form a typical pattern of darker features and lighter skin (Sinha, 2002), and elsewhere we have demonstrated that the difference in luminance between facial features (eyes and mouth) and skin—termed "facial contrast"—is sexually dimorphic (Russell, 2009). Female faces have higher facial contrast on average than males due to female skin being lighter than male skin, though female features are not lighter than male features. Facial contrast correlates positively with ratings of femininity and negatively with masculinity, and alterations to facial contrast make an androgynous face appear male or female (Russell, 2009). Alterations to facial contrast also impact the attractiveness of faces. Increasing the contrast of the eyes and mouth leads to higher attractiveness judgments for females, but attenuates the same judgments for males, with the reverse being true for decreases in contrast (Nestor and Tarr, 2008; Russell, 2003).

Facial contrast also plays a role in perception of age, beyond more obvious cues such as wrinkles. Porcheron, Mauger, and Russell (2013) demonstrated that aspects of facial contrast change with age, with the majority of feature contrasts decreasing as individuals grow older across a range of color sources, such as lip redness. Porcheron et al. (2013) also showed that not only do these contrasts predict judgments of age, but that manipulating these contrasts can make faces appear younger or older depending on the direction of the manipulation. Facial contrast therefore impacts perceptions of youth, which is a key component of female facial attractiveness as it is a cue to reproductive potential (Jones, 1996).

An extremely widespread behavior that increases female facial attractiveness is the use of cosmetics. Cosmetics increase attractiveness in a variety of ways, such as through smoothing skin texture (Samson, Fink, and Matts, 2010). However, when women apply cosmetics, they do so in a manner that consistently exaggerates the sex difference in facial contrast, by darkening features relative to the surrounding skin (Etcoff, Stock, Haley, Vickery, and House, 2011; Russell, 2009). It is unlikely that the manipulation of facial contrast achieved by cosmetics is done by chance. The "received style" of cosmetics (Russell, 2010), darkening features relative to the skin, is prevalent across modern societies as well as archaeological records, indicating it is consistent throughout history (Corson, 1972). It is unsurprising that women are rated consistently as more attractive with cosmetics (Cash, Dawson, Davis, Bowen, and Galumbeck, 1989; Etcoff et al., 2011; Mulhern, Fieldman, Hussey, Lévêque, and Pineau, 2003; Nash, Fieldman, Hussey, Lévêque, and Pineau, 2006), or that women use cosmetics as a mate attraction technique (Buss, 1988). As facial contrast decreases with age (Porcheron et al., 2013), it is possible

that cosmetics may also function by making faces appear younger, increasing at least some of the contrasts that decline with age. Cosmetics may beautify faces by modifying contrasts that are cues to sexual dimorphism and youthfulness, which are predictors of female mate value (Jones, 1996).

However, there remain aspects of facial contrast that are not understood. There exists a sexual dimorphism in both eyebrow thickness (i.e. the distance from the bottom edge to the top edge of the brow) and brow-to-eye distance (Farkas and Munro, 1987), with females possessing higher and thinner brows. Some grooming behaviors of modern women already seem to simultaneously accentuate both these dimorphisms by plucking the brow from the bottom (Aucoin, 1997), making this facial feature more feminine. Lower brow thickness is also associated with greater attractiveness (Kościński, 2012). Because plucking reduces the density of eyebrow hairs, revealing more of the underlying skin, it may also result in decreased contrast between the brow and the surrounding skin. When ambiguous faces are classified as male, they tend to have darker eyebrows than faces classified as female (Nestor and Tarr, 2008). Additionally, the luminance pattern of the eyes and the brows play an important role in classifying faces as male or female (Dupuis-Roy, Fortin, Fiset, and Gosselin, 2009). These findings suggest there may be a sex difference in brow contrast - possibly due to the sex difference in the likelihood of plucking the brow. If this is the case, it may not be just be eye contrast that signals information about sex, but the combined contrast pattern of the eyes and brow. However, previous studies investigating sex differences in facial contrast (Russell, 2009; Stephen and McKeegan, 2010) have not investigated contrast around the eyebrow. We predict that, given the greater thickness of hair in male brows, there should exist a sexual dimorphism in brow contrast, with males having greater brow contrast than females.

While other studies have examined the role that different color channels contribute to perceptions and classifications of sex (Nestor and Tarr, 2008; Dupuis-Roy et al., 2009), these studies have not specifically examined whether there are sex differences in facial contrast across features. For this reason, we investigate sex differences in luminance, red-green and yellow-blue contrasts for the eyebrows, eyes, and mouth, an approach used previously by Porcheron et al. (2013) to examine changes in facial contrast with age. Related, it is unknown whether contrasts that decrease with age are actually enhanced by cosmetics. We predict that cosmetics will increase color contrasts related to youthfulness for the mouth and eyes. However, for the brow, it is unclear how cosmetics may be used - if females have lower brow contrasts than males, they should decrease their brow contrast with cosmetics to enhance sexual dimorphism. However, this is a contrast that declines with age, and which correlates with perceptions of age. This may lead to a conflict of signaling attractiveness and youth, which we expand on later. Further, other studies have found contradictory evidence to facial contrast playing a role in perceptions of certain traits. Stephen, Law-Smith, Stirrat and Perrett (2009) found minimal evidence of an effect of mouth contrasts on perceptions of health, a trait linked with attractiveness (Shackelford and Larsen, 1999), and no evidence of sex differences in the effect of mouth contrast on perceptions of health. Stephen et al. (2009; page 854) suggested that the use of black and white images by Russell (2003) could have eliminated important color cues to sexual dimorphism in facial contrast. A further suggestion by Stephen et al. (2009) was that the effects of facial contrast on trait perceptions (Russell, 2003; 2009) could be due more to

contrast from the eye region than from the mouth. We will provide evidence bearing on both of these suggestions.

In Experiment 1, we measure facial contrast in groups of Caucasian and East Asian individuals, measuring sex differences in color and luminance contrasts across three sources of contrast in the face: The brows, eyes, and mouth. We predict that luminance contrasts should be higher for the eyes and mouth in female faces, but lower for brow contrasts. Then, in Experiment 2, we examine the contrast changes in features across color and luminance channels before and after an application of cosmetics, to test whether cosmetics increase the sexual dimorphism in facial contrast, and alter those contrasts that decrease with age. We predict that cosmetics should increase contrasts that exaggerate sexual dimorphism, and also those that decrease with age.

Experiment 1 – Sex Differences in Facial Color Contrasts

Across three sets of faces (hereafter Sets One, Two and Three) we calculated contrast for the eyebrows, eyes, and mouth, and examined differences between the sexes. We examined feature contrasts using the CIEL*a*b* color space, which is modeled on human color perception, yielding information about skin color in perceptually relevant terms (Weatherall and Coombs, 1992). For all image sets, Bangor University students were asked to remove all traces of facial cosmetics and jewelry, to tie their hair back from the face as necessary, and to maintain a neutral expression while looking into the camera. Males were clean-shaven. Models were paid £6 for their participation.

Ethics statement
All experiments presented in this article were carried out under the approval of the institutional review board at Bangor University.

Materials and Methods

Model demographics and image capture
Set 1. Seventy-three females (18 – 28 years, $M = 20.23$, $SD = 2.47$) and 43 males (18 – 28 years, $M = 20.30$, $SD = 2.35$) Caucasian individuals, who self reported their ethnicity as White, were photographed using a Canon EOS 5D MII camera, with professional diffused lighting and reflectors. Participants were photographed at a distance of approximately one meter, against a white background. We kept lens aperture (F8.0), exposure time (1/100 s) and ISO speed rating constant (100) for all photographs.
Set 2. One hundred and thirty-four females (18 – 28 years, $M = 20.53$, $SD = 2.00$) and 57 males (18 – 30 years, $M = 20.70$, $SD = 1.95$) Caucasian individuals, who self reported their ethnicity as White, were photographed using the same camera as Set One, but without reflectors and at a different time. Participants were photographed at a distance of approximately one meter, against a white background. We kept lens aperture (F9.0), exposure time (1/25 s) and ISO speed rating constant (125) for all photographs.
Set 3. Seventy-nine females (18 – 29 years, $M = 22.89$, $SD = 2.65$) and 55 male (18 – 30 years, $M = 23.36$, $SD = 4.01$) East Asian students were photographed against a white background at a distance of approximately one meter with a Nikon D3000 camera, with a

camera-mounted flash angled 45º towards the ceiling. As before, lens aperture (F4.5), exposure time (1/160 s), and ISO speed rating (200) were constant across photographs.

As lighting differences are inconsistent across these three image sets, we do not directly compare values between faces of different sets (e.g., to say whether one race has greater contrast than another), but instead compare the sex differences in contrasts within sets only. All pictures were captured in a raw format.

Image analysis procedure

All faces were manually landmarked using JPsychomorph, with a template of 179 points (Tiddeman, Burt and Perrett, 2001). The eyes, eyebrows and mouth were delineated for each face, with landmarks conforming closely to the edges of these features, as is standard practice when delineating faces for averaging and texture transforms. Custom MATLAB software (Version R2009b; The Mathworks Inc, Massachusetts) was written to extract the landmarks surrounding the eyes, eyebrows, and mouth for each face. We also derived an area around each of the three features to form an annulus, which captured the surrounding skin coloration. All regions of interest (ROI) are illustrated in Figure 1. For the mouth region, this was achieved by expanding the region surrounding the mouth by a factor of two. For the eye region, we incorporated landmarks that delineated the nasal bridge and periorbital circles, and the landmarks that delineated the very bottom of the brow, creating an annulus that was approximately double the eye region. For the brow region, we raised the Y-coordinate of the landmarks along the top of the brow by 50 pixels to define the upper boundary of the brow annulus, and used the landmarks above the eye to define the lower boundary of the brow annulus. In this way, the ROI's were derived in exactly the same manner for each face, but were based upon the specific landmarks placed on each model.

We converted the RGB image of each face into CIEL*a*b* color space using MATLAB. This color space has three orthogonal dimensions: luminance (*L**), red-green (*a**), and yellow-blue (*b**). Pixel values for each color channel range from 0 (*L**, black; *a**, green; *b**, blue) to 255 (*L**, white; *a**, red; *b**, yellow), instead of the traditional 0 – 100 and -127 to +127 CIEL*a*b* scales. This is because MATLAB represents L*a*b* color using unsigned 8 bit integer values, which by definition cannot be negative (see Baldevbhai and Anand, 2012, for a primer on digital representations of color spaces). MATLAB converts RGB images to CIEL*a*b* color space using the profile connection space (PCS) described the International Color Consortium guidelines for conversion (ICC; International Color Consortium, 2004). RGB values were converted using the PCS to 1976 CIEL*a*b* color values, with a d50 illuminant white point reference.

To calculate facial contrast, luminance values of pixels within both eye regions were averaged, as were the luminance values within brow features, as well as the luminance values of the lips. Similarly, we separately averaged the pixel values of the annuli surrounding the eyes, brows, and the mouth. The average values from within both eye features were then averaged to produce a mean eye feature value, with the same process repeated for the brow features, eye annuli, and brow annuli. The contrast of each feature was derived using Russell's (2009) adapted Michelson contrast, as follows: C_{L*} = (skin *L** - feature *L**)/(skin *L** + feature *L**). Values range from -1 to 1; with positive values indicating the surrounding skin has a higher luminance value than the feature, and negative numbers indicating the reverse. These calculations were repeated for the a* and b*

channels. For red-green contrasts, a positive value indicates the surrounding skin is redder than the feature, while for yellow-blue contrasts a positive value indicates the surrounding skin is yellower than the feature.

Given that both ends of the contrast spectrum (i.e., positive and negative) can be interpreted as being of greater contrast, we provide means in Table 1. However, unless otherwise stated, the majority of contrast values are positive (i.e., the skin has a greater color value than the feature).

Figure 1. An illustration of the ROI's used to extract color information for the eye, mouth, and eyebrow features
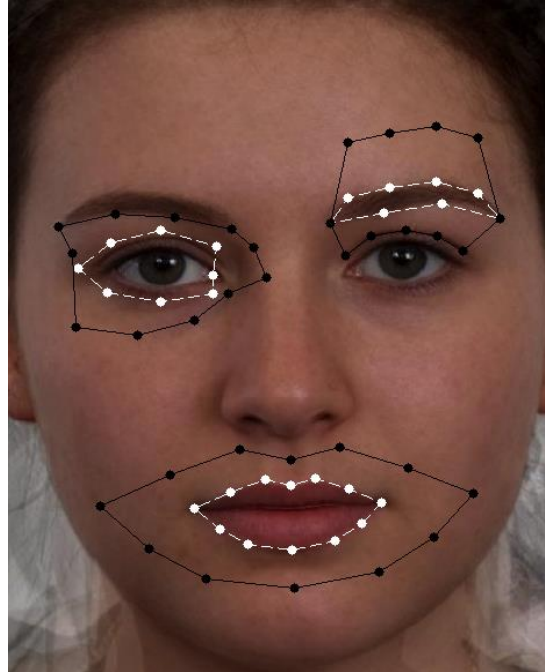
Note. Dashed white lines denote feature areas, while solid black lines represent the annuli. Eye and eyebrow features were calculated for both sides.

Results

For each image set, in each color channel, we used a 3 (Feature: Eyebrows, Eyes, Mouth) x 2 (Sex: Female, Male) mixed model ANOVA to test for sex differences across different features. Across all of these tests, we observed significant interactions (reported in Table 1) between Feature and Sex, indicating differences in contrasts between males and females across features. These interactions are explored further below, separately for each color channel. Sex differences in feature contrasts across color channels and image sets are also illustrated in Figure 2.

Luminance contrasts

In Set 1, the Feature x Sex interaction was driven by higher Brow contrast in males compared to females, $t(114) = 2.27$, $p = .03$, $d = 0.44$, and by females having significantly higher Eye luminance contrast than males, $t(114) = 3.24$, $p = .002$, $d = 0.62$. The same pattern was observed in Set 2, with males having higher Brow contrast than females, $t(189)$

= 4.66, $p < .001$, $d = 0.73$, and females having higher Eye contrast than males, $t(189) = 3.98$, $p < .001$, $d = 1.25$, as well as in Set 3, with higher Brow contrast in males, $t(80.69) = 6.35$, $p < .001$, $d = 1.14$, and higher Eye contrast in females, $t(132) = 5.36$, $p < .001$, $d = 0.96$. Across all sets, mouth contrast was numerically greater in females than males, although this was significant only for the East Asian group (Set 3), $t(132) = 2.68$, $p < .001$, $d = 0.52$, and not the two Caucasian groups, both $ts < .92$, $ps > .30$, Set 1 $d = 0.19$, Set 2 $d = 0.13$.

Table 1. Means, standard errors, and feature x sex interactions of contrast values across color channels and image sets

Image Set	CIEL*a*b* Channel	Sex	Feature			Feature x Sex Interaction
			Eyebrows	Eyes	Mouth	
Set 1 (Caucasian)	Luminance	Female	.159 (.009)	.148 (.004)	.121 (.004)	9.97^{*} $\eta^2_p = .08$
		Male	.192 (.012)	.127 (.005)	.114 (.005)	
	Red-green	Female	.000 (.001)	.010 (.001)	-.047 (.001)	8.32^{*} $\eta^2_p = .07$
		Male	.005 (.001)	.011 (.001)	-.048 (.001)	
	Yellow-blue	Female	.001 (.001)	.018 (.001)	.013 (.001)	$4.32^{\dagger}$ $\eta^2_p = .04$
		Male	.003 (.002)	.017 (.001)	.008 (.001)	
Set 2 (Caucasian)	Luminance	Female	.233 (.008)	.217 (.004)	.153 (.003)	29.14^{*} $\eta^2_p = .13$
		Male	.300 (.012)	.188 (.006)	.149 (.004)	
	Red-green	Female	.007 (.001)	.022 (.000)	-.031 (.001)	37.74^{*} $\eta^2_p = .16$
		Male	0.15 (.001)	.020 (.001)	-.031 (.001)	
	Yellow-blue	Female	.005 (.001)	.020 (.000)	.003 (.001)	23.08^{*} $\eta^2_p = .12$
		Male	.011 (.001)	.019 (.001)	.002 (.001)	
Set 3 (East Asian)	Luminance	Female	.143 (.006)	.146 (.003)	.111 (.002)	55.70^{*} $\eta^2_p = .29$
		Male	.210 (.007)	.121 (.004)	.101 (.003)	
	Red-green	Female	.009 (.001)	.011 (.000)	-.043 (.001)	43.19^{*} $\eta^2_p = .25$
		Male	.021 (.001)	.010 (.001)	-.041 (.001)	
	Yellow-blue	Female	.023 (.001)	.021 (.001)	.017 (.001)	59.04^{*} $\eta^2_p = .31$
		Male	.033 (.001)	.019 (.001)	.016 (.001)	

Note. Numbers in parentheses denote *SEM*. All values are reported to 3 d.p. due to the scale of contrast measurements. Degrees of freedom for interactions: Set 1, $F(2, 228)$; Set 2, $F(2, 378)$; Set 3, $F(2, 264)$. Significance of *F*-ratios: $\dagger p < .05$, $*p < .001$.

Figure 2. Average contrasts across image sets, contrast sources, and color channels
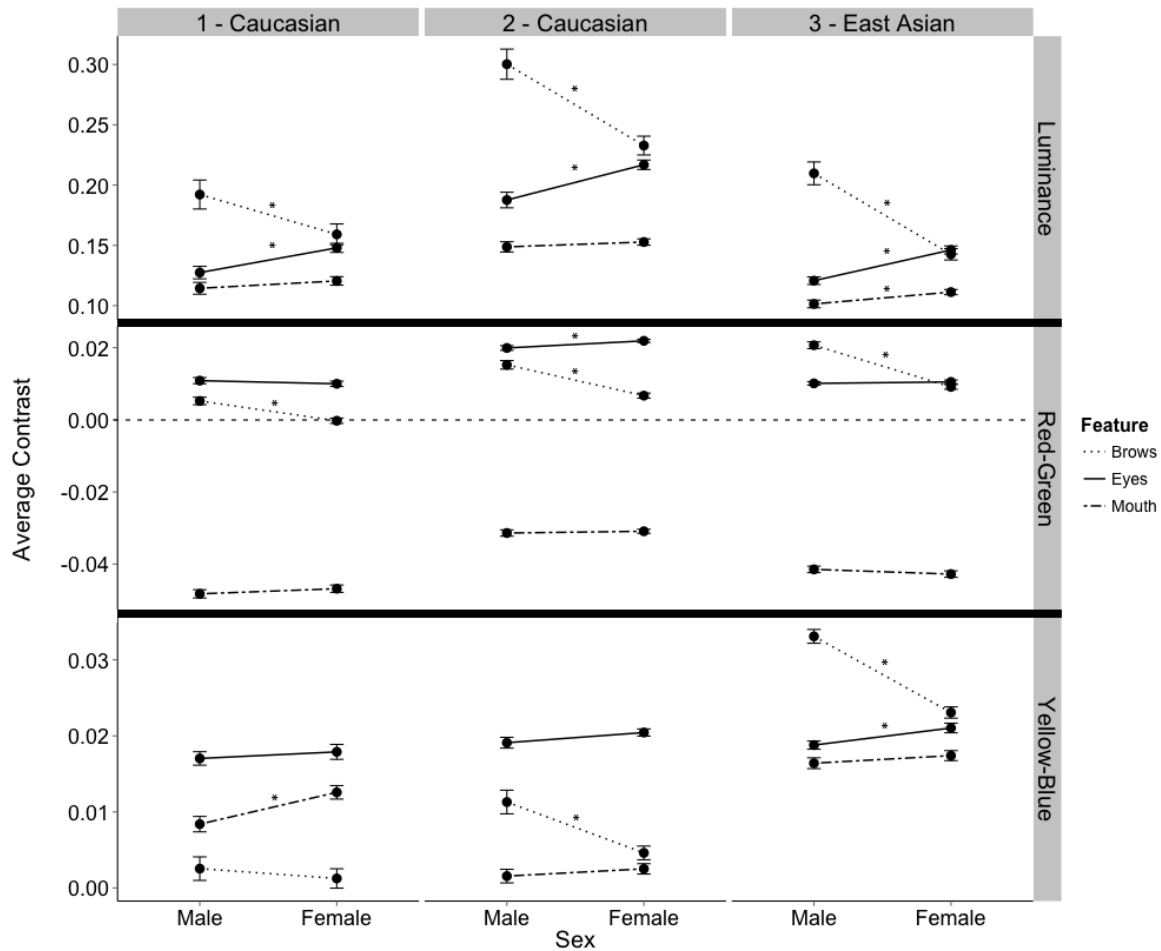
Note. Scales differ between color channels. Asterisks indicate a significant sex difference in feature contrast values. Error bars represent ±1 SEM.

As a measure of contrast is a ratio between two sources of color, it is unclear what causes the contrast. For example, it is possible skin luminance does not differ between the sexes, but females possess darker eyes and lips than males but lighter eyebrows. If this were systematic, it would cause the differences stated above. To illustrate this more clearly, we compared raw feature and annulus luminance values between sexes for the features in the significant comparisons above. Across all of the image sets, there were no sex differences in raw eye feature luminance, all ts < .189, but eye annuli were significantly lighter in females, all ts > 5.82, ps < .001, indicating the sex difference in eye contrast is driven by fairer skin in females (Russell, 2009). Further to this, across all image sets, the eyebrow feature was consistently darker in males, all ts > 8.23, ps < .01. Eyebrow annuli was also darker in male faces, all ts > 6.74, ps < .02. Darker brows led to greater contrast in male faces compared to lighter brows and lighter skin in female faces.

We also observed lighter lips in East Asian females, $t(132) = 3.68$, $p < .001$, but there was an even greater sex difference in the surrounding skin, $t(132) = 5.36$, $p < .001$, which drove the sex difference in luminance contrast around the lips. In Set 2, there were also differences in luminance values - females had lighter lips, $t(189) = 2.50$, $p = .01$, but also had much lighter skin than males, $t(189) = 3.71$, $p < .001$. The sex difference in eye

and mouth contrast seems to be driven by lighter skin in females, while the sex difference in eyebrow contrast is caused both by lighter skin in females and darker brows in males.

Red-green contrasts

In Set 1, the Feature x Sex interaction was driven by males having greater red-green contrasts for the Brows, $t(114) = 4.40$, $p < .001$, $d = 0.76$, while in Set 2, males had greater contrast for the Brows, $t(189) = 6.46$, $p < .001$, $d = 0.94$, and females had greater Eye contrast than males, $t(189) = 2.53$, $p = .01$, $d = 0.40$. In Set 3, the interaction was caused by higher Brow contrast in males, $t(132) = 10.40$, $p < .001$, $d = 1.84$. Mouth contrasts across sets did not differ between sexes, nor did other feature contrasts, all ts < 1.01, all ps > .32.

Yellow-blue contrasts

The Feature x Sex interaction in Set 1 was driven by females having higher yellow-blue contrasts for the Mouth, $t(114) = 2.99$, $p = .003$, $d = 0.77$, though in Set 2 it was caused by males having higher Brow contrast, $t(189) = 3.90$, $p < .001$, $d = 0.54$. In Set 3, males had greater Brow contrast than females, $t(132) = 8.57$, $p < .001$, $d = 1.53$, and females possessed higher Eye contrast than males, $t(131.92) = 2.71$, $p = .008$, $d = 0.46$. Other mouth contrasts were not significant, nor were other feature contrasts, all ts < 1.56, all ps >.55.

Discussion

The results from this experiment refine the notion of sexual dimorphism in facial contrast. While Russell (2009) demonstrated that female faces have greater mouth and eye contrast than males, we have further unpacked the cues to sexual dimorphism in the upper face area, finding a divergent pattern of luminance contrasts of the eyes and brow. While females possess greater eye contrast than males (Russell, 2009), males possess greater eyebrow contrast than females, a difference consistent across race.

The results with luminance contrast around the mouth are somewhat less clear. There was greater contrast in the female faces in all three sets ($d = 0.19$ in Set 1, $d = 0.13$ in Set 2, and $d = 0.52$ in Set 3). However, this sex difference was statistically significant only with the East Asian faces (Set 3). However, Russell (2009) and Stephen and McKeegan (2010) found that females have greater mouth luminance contrasts than males in Caucasian but not East Asian faces. The effect size for the sex difference in mouth luminance contrast was approximately $d = 0.70$ in the Caucasian face set of Stephen and McKeegan (2010), and $d = 0.58$ in the Caucasian face set and $d = 0.11$ in the East Asian face set of Russell (2009).

To examine this further, we conducted a basic meta-analysis on the six reported d scores of mouth luminance contrast. Using a random effects model (Field, 2005), we found that the sex differences in mouth contrast were homogenous across samples, $X^2(5) = 6.39$, $p = .27$. Moreover, the average sex difference in mouth luminance contrast was $d = 0.34$ (95% CI [0.14, 0.53]), $SEM = 0.09$, with a significant population effect size, $z = 3.42$, $p = .001$. Given these results, we can conclude there is a sex difference in mouth luminance contrast, but that in general it is smaller than the sex difference in eye contrast, which, from the data in this study, and that of Russell (2009), has an average sex difference of $d = 0.78$ (95% CI [0.46, 1.12]), $SEM = 0.17$. This result also supports the third suggestion of

Stephen et al. (2009, p. 854), who noted that perceptions of sexual dimorphism from facial contrast could stem more from the eye region than the mouth.

We also found consistent differences when examining red-green contrast. Males possessed higher red-green contrasts around the brows. This is possibly due to males having redder skin than females in general. Consistently, males had higher yellow-blue contrast around the brows than women, but the samples differed on little else. The greater brow contrasts in male faces in all three color channels could be due to males having a higher density of eyebrow hairs. A lower density of hairs would reveal more of the underlying skin, resulting in a lower contrast with the surrounding skin. There were some findings that were inconsistent across image sets. In Set 1, females had greater yellow-blue mouth contrasts than males, and in Set 2 females had higher red-green contrast than males. These inconsistent differences suggest a lack of sexual dimorphism in these color channels.

Experiment 2 – Contrast Alterations with Cosmetics

The application of facial cosmetics allows an individual to alter their appearance in a multitude of ways. However, a typical cosmetics application, referred to as the "received style" (Russell, 2010) follows a consistent pattern of increasing skin homogeneity (evenness of skin tone) and darkening of facial features, an effect consistent across cultures and historical records (Corson, 1972). This exaggerates precisely the sexual dimorphism in facial contrast identified by Russell (2009), and we predict should increase some of the contrasts shown to decrease with age (Porcheron et al., 2013).

The results from Experiment 1 refine the notion of sex differences in facial contrast, demonstrating a divergence in luminance contrasts of the eyes and brow. Grooming behaviors involving the brow seem to be designed to reduce contrast - plucking is extremely common, and presumably decreases contrast by removing hairs, and is standard beauty advice (Aucoin, 1997). Indeed, brow thickness in female faces is negatively correlated with perceived attractiveness (Kościński, 2012). However, this is a more enduring manipulation, affecting facial appearance both with and without cosmetics. Indeed, this is possibly the reason for the sexual dimorphism in luminance contrasts observed in Experiment 1. However, cosmetic products like eyebrow pencils are prevalent historically (Corson, 1972) and are a staple in modern day makeup practices. These products are designed to darken brows, possibly reversing age related declines in brow feature contrast (Porcheron et al., 2013). By examining how women typically apply cosmetics, we can affirm if sexual dimorphism in brow contrasts is relevant for a sexually dimorphic appearance, or whether the manipulation of the brows by cosmetics serves to alter contrasts associated with age. Further to this idea, Stephen and McKeegan (2010) identified that in female faces, perceptions of femininity are enhanced by higher red-green and lower yellow-blue mouth contrasts. These contrasts are modifiable by cosmetics, and we examine these changes here by incorporating other color channels as in Experiment 1 to provide a fuller understanding of the enhancement in facial contrast cosmetics achieve, and the multiple signal channels cosmetics likely act upon (e.g., sexual dimorphism or age).

We make several predictions regarding the use of cosmetics here. First, we predict that women will apply cosmetics that will enhance sexual dimorphisms in eye and mouth luminance contrasts, likely by darkening the eyes and mouth and lightening the skin around these features (Russell, 2009). We also predict that red-green and yellow-blue eye contrasts

should be increased with cosmetics, as they are contrasts that decline with age. Cosmetics should reduce the red-green contrast of the mouth by increasing the redness of the lips, a manipulation that has been shown to make female faces appear more sex typical and attractive (Stephen and McKeegan, 2010), and as it is a contrast that increases with age (Porcheron et al., 2013), reduction of this contrast should cue youthfulness. Similarly, we predict that the yellow-blue contrast of the mouth should be lowered by the use of cosmetics, as this contrast reduction is also associated with perceptions of sex typicality and attractiveness (Stephen and McKeegan, 2010), and also increases with age (Porcheron et al., 2013). If these predictions are supported, then cosmetics will enhance contrasts related to both sexual dimorphism as well as youth.

For the brow feature, cues of sexual dimorphism and youth are in conflict. We demonstrated in Experiment 1 females have consistently lower luminance contrasts in the brow than males, but a reduction of brow contrast occurs with age. It is therefore difficult to predict whether cosmetics would increase brow luminance contrast to cue youth at the expense of a sexually dimorphic appearance, or lower brow luminance contrast to cue sexual dimorphism at the expense of youthfulness.

Method

Forty-four Caucasian females (18–27 years, $M = 21.18$, $SD = 1.94$), who self reported their ethnicity as White, were recruited as models. Models removed all traces of cosmetics they were wearing, along with facial jewelry. Models were then photographed with a natural appearance.

We provided models with a range of popular cosmetics, all of the same brand. These included two shades of eyeliner and two shades of brow pencils, four varieties of mascara, six shades of foundation, ten shades of eyeshadow, and over ten varieties of lipstick. Models were invited to apply cosmetics as they would for a "night out", before being photographed again. This context was chosen to provide a common scenario in which females may use cosmetics to maximize their attractiveness (Buss, 1994; Singh, 2004), and has been used in previous research (Russell, 2009). Photographs were taken with a Nikon D3000 camera against a white background. Lighting was standardized from a flash angled 45° towards the ceiling. For all photographs, camera settings were kept constant, including lens aperture (F5.3), exposure time (1/60 s), and ISO speed rating (200). Contrasts were derived and analyzed exactly as described in Experiment 1.

Results

We sought to examine the differences in contrasts brought about by an application of cosmetics. To do this, we used a 2 (Cosmetics: Without, With) x 3 (Feature: Brows, Eyes, Mouth) repeated measures ANOVA for each color channel separately. As before, we examine the interactions, as we are interested in how features might diverge with an application of cosmetics. Feature contrasts before and after an application of cosmetics are illustrated in Figure 3.

Figure 3. The interaction between Cosmetics and Features, illustrated across color channels
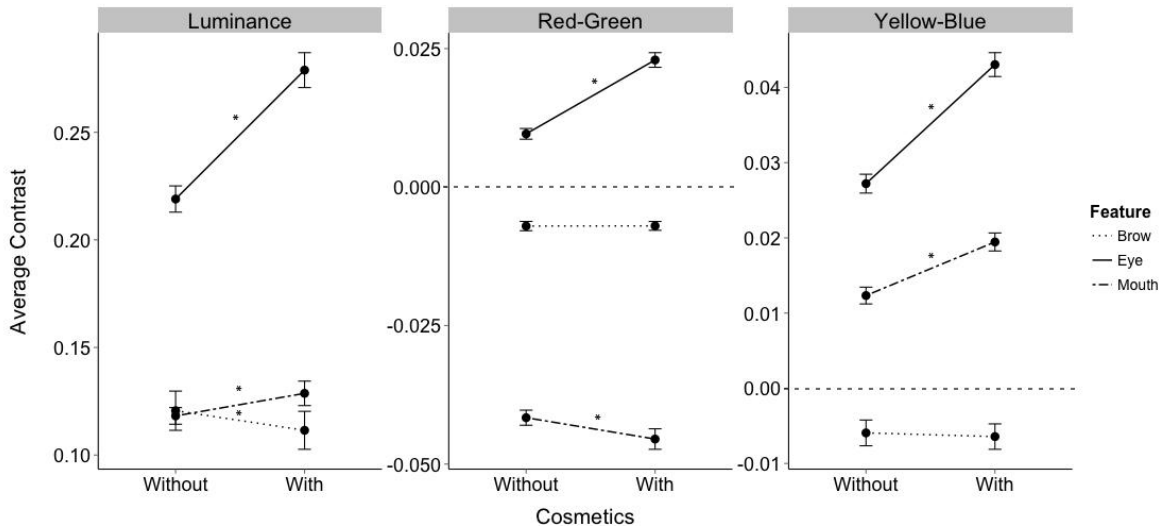
Note. Asterisks represent a significant change in feature contrast values with cosmetics; Error bars represent ±1 *SEM*.

Luminance contrasts

The predicted Cosmetics x Feature interaction was significant, $F(2, 86) = 62.83$, $p < .001$, $\eta^2_p = .59$. Consistent with previous research, Eye feature contrasts increased significantly with an application of cosmetics, $t(43) = 9.73$, $p < .001$, $d = 1.46$, as did Mouth contrasts, $t(43) = 2.13$, $p = .04$, $d = 0.32$. We also observed a significant decrease in Brow luminance contrasts, $t(43) = 3.47$, $p = .001$, $d = 0.52$. As contrast is a ratio, we sought to examine whether females decreased brow contrast by darkening the surrounding skin or by lightening the brow feature itself. A further paired *t*-test between raw brow feature luminance values revealed this feature was marginally yet consistently lightened by an application of cosmetics, $t(43) = 2.05$, $p = .05$, $d = 0.31$ (without cosmetics luminance value $M = 121.07$, $SD = 17.66$, with cosmetics, $M = 122.82$, $SD = 16.25$). The brow annulus was slightly darker with cosmetics, though not significantly, $t(43) = 0.61$, $p = .55$, $d = .09$ (without cosmetics luminance value: $M = 152.96$, $SD = 7.00$; with cosmetics: $M = 152.60$, $SD = 7.25$). It is unusual that cosmetic practices would specifically lighten the brow, as the majority of cosmetic products for the eyebrow are geared towards darkening the feature. Additionally, the eyebrow annulus is comprised of regions that are modified by cosmetics in divergent directions. Eye shadow is typically applied below the brow, and foundation is perhaps applied above. Importantly, some evidence demonstrates that the area directly above the eye and below the brow, when darkened with cosmetics, increases perceptions of attractiveness (Killian and Peissig, 2013).

To explore this further, we isolated the region of skin directly above the eye and below the brow, and calculated the raw luminance values in this area before and after cosmetics application. In Figure 1, this is the region in the brow annulus directly under the eyebrow but above the eye, which we now refer to as the upper eye region. This area was darkened significantly with an application of cosmetics, $t(43) = 4.85$, $p < .001$, $d = 0.73$ (without cosmetics luminance value: $M = 121.83$, $SD = 12.41$; with cosmetics: $M = 106.83$, $SD = 12.52$), indicating that while the brow feature was altered directly with cosmetics, the

region under the brow was also manipulated (and to a greater extent), contributing to contrast alterations. This manipulation would serve to decrease eye contrast by darkening the adjacent area, thereby increasing sexual dimorphism in the brow feature at the expense of sexual dimorphism in the eye feature.

Red-green contrasts

The predicted Cosmetics x Feature interaction was significant, $F(2, 86) = 64.92$, $p < .001$, $\eta^2_p = .60$. The interaction was driven by divergent changes in Eye and Mouth contrast. Red-green contrasts were increased by cosmetics, $t(43) = 13.89$, $p < .001$, $d = 2.09$. As expected, cosmetics decreased Mouth contrasts even further (increasing the absolute value of contrast), $t(43) = 2.38$, $p = .02$, $d = 0.36$, further enhancing the redness contrast of the mouth. The raw values of the upper eye region decreased (made greener) with cosmetics, $t(43) = 8.24$, $p < .001$, $d = 1.24$ (without cosmetics red-green value: $M = 150.10$, $SD = 1.77$; with cosmetics: $M = 147.48$, $SD = 1.91$), indicating a role in modulating eyebrow contrast. However, overall brow contrasts in this channel did not alter with cosmetics, $t(43) = .06$, $p = .95$.

Yellow-blue contrasts

A further Cosmetics x Feature interaction was significant, $F(2, 86) = 88.86$, $p < .001$, $\eta^2_p = .67$. This interaction was again driven by changes in Eye and Mouth contrasts, which were both increased by cosmetics, Eyes, $t(43) = 13.23$, $p < .001$, $d = 1.99$, Mouth, $t(43) = 5.75$, $p < .001$, $d = 0.86$. An additional analysis of the upper eye region showed that pixel values in this area were reduced (made bluer) with cosmetics, $t(43) = 7.04$, $p < .001$, $d = 1.05$ (without cosmetics yellow-blue value: $M = 157.78$, $SD = 1.83$; with cosmetics: $M = 155.11$, $SD = 2.37$). Brow contrasts in this channel did not alter with cosmetics, $t(43) = .68$, $p = .49$.

Discussion

Our predictions that cosmetics alter contrasts that enhance sexual dimorphism were partially supported. An application of cosmetics increased luminance contrasts of the eyes and mouth, but decreased luminance contrasts of the eyebrows, exaggerating differences in luminance between the sexes. It is notable that the faces with makeup had reduced rather than increased luminance contrast of the eyebrow, which is unusual. Though lower eyebrow contrast is feminine, it is also typical of older faces, indicating that for this group of young adult participants, makeup may have enhanced femininity at the expense of youthfulness. Although a marginal reduction of eyebrow feature luminance was detected, this is probably not the washing out of luminance this feature undergoes with age.

Both the evidence presented in Experiment 1 and the results of others (Stephen and McKeegan, 2010) suggest that red-green contrasts of the mouth are not sexually dimorphic. However, when participants applied lipstick, the value of this contrast source was decreased, as lips became redder. Other studies have shown that decreasing the red-green contrast of the mouth increases perceptions of femininity and attractiveness in females (Stephen and McKeegan, 2010). Why might this be? There are two possible answers to this question. The first is that red lips are youthful. The red-green contrast of the mouth increases with age, and, in older faces, decreasing this contrast makes a face look younger

(Porcheron et al., 2013). As youth is a component of female attractiveness (Jones, 1996), the red green contrast of the mouth is likely a cue to age and therefore attractiveness. That is, even though red lip color is not dimorphic, it is still a valuable cue to be accentuated for women's attractiveness. The second reason may relate to the motivational value of the color red. Men find women both more physically and sexually attractive in the presence of the color red (Elliot and Niesta, 2008), and males engage in approach behaviors more often when viewing a female wearing the color red (Niesta Kayser, Elliot, and Feltman, 2010), and perceive women wearing red to have more sexual intent (Guéguen, 2012a). In non human female primates, the color red is used to signal the onset of ovulation across a variety of bodily regions, induced by increased blood flow from higher circulating levels of estrogen (Dixson and Herbert, 1977). This is a signal used by male conspecifics as an honest signal of ovulation (Deschner, Heistermann, Hodges, and Boesch, 2004). Concordantly, human females wear more red clothing (Beall and Tracey, 2013) and cosmetics around ovulation (Guéguen, 2012b). It is perhaps unsurprising that the color red has been a popular choice for lipstick since antiquity (Regas and Kozlowski, 1998). The red-green contrast of the mouth, exaggerated by cosmetics, may function as a supernormal stimulus, cueing not only youth, but also information about sexual intent.

Our prediction that yellow-blue mouth contrasts would be reduced was unsupported. Instead, cosmetics increased this contrast, indicating the skin was yellower than the lips, the reverse of the pattern shown by Stephen and McKeegan (2010). Though this contrast increases with age (Porcheron et al., 2013), the increase in skin yellowness here may have an effect on perceived health. Higher levels of skin yellowness in the form of carotenoids are perceived as more healthy (Stephen, Coetzee, and Perrett, 2011), and so this yellowness increase may offset any alterations to perceived age brought about by this alteration.

We found that cosmetics increased the red-green and yellow-blue contrasts of the eyes, making the skin redder and yellower than the feature. Porcheron et al. (2013) demonstrated that these contrasts reduce with age. These results illustrate that cosmetics alter the color contrasts of features that are associated not only with sexual dimorphism, but also with youth, offering an additional explanation of how cosmetics beautify faces - by increasing cues to youth.

Finally, we observed no changes in brow contrast in other channels apart from luminance. This is surprising; given that in Experiment 1 we observed a consistent sex difference in all channels for brow contrast. However, luminance contrasts were still altered in sex typical directions, and the upper eye region was manipulated by cosmetics by darkening the area while making it greener and bluer. It is likely that when considering the contrast of the brow directly, with skin both above and below the eyebrow, a smaller effect of brow contrast manipulation was observed. However, the action of cosmetics like eye shadows, which darken the upper eye region, serves to increase eye contrast and simultaneously decrease brow contrast by lessening the contrast of the brow with the immediately surrounding skin. The analyses presented here show that cosmetics act on brow contrast both directly, by altering the brow feature, and indirectly, by manipulating areas directly around the brow.

These findings extend those of Russell (2009), illustrating that women apply cosmetics to alter sexually dimorphic contrast patterns across facial features by exaggerating the differences between males and females. Further, cosmetics were used to

enhance contrasts related to youth and perceived sex typicality. In the case of eyebrows, the cues for these desirable traits are in apparent conflict: a signal of youth (higher contrast) is opposed to a signal of femininity (low contrast). In this case, the women in our sample chose to reduce contrast (by shadowing the area under the eye). The use of cosmetics products like eye shadow may in fact offer an explanation of the conflicting cues of femininity and youth that stem from the eyebrow feature. Age may reduce the contrast of the feature, but femininity may be signaled more clearly from the region above the eye, a signal enhanced by the women in our sample.

Do cosmetics increase attractiveness?

Finally, it is important to consider whether the cosmetics applied by the models increased their attractiveness, which is a consistent finding (Cash et al., 1989; Etcoff et al., 2011; Mulhern et al., 2003). Jones and Kramer (2015) utilized the same models as in this study, and had them rated for attractiveness in both cosmetics conditions by 62 participants. Models were rated as more attractive with cosmetics than without, $t(43) = 3.28$, $p = .002$, $d = 0.57$ (though see Jones and Kramer, 2015, for a fuller discussion of this finding). Additionally, observers find the same models optimally attractive with significant amounts of cosmetics when given the option to vary the amount of cosmetics on the face (Jones, Kramer, and Ward, 2014). Taken together, these findings show that the cosmetics used by the models successfully increased their attractiveness.

General Discussion

We have demonstrated that luminance contrasts of the eyes and brow diverge consistently between the sexes, supporting our hypothesis that eyebrow contrast should be sexually dimorphic. This sexual dimorphism in contrast was exaggerated by the use of cosmetics, an application of which decreased brow contrast but increased eye contrast. We show that the area directly above the eye and below the eyebrow is darkened with cosmetics, reducing the brow contrast. Darkening of this area results in increased attractiveness judgments of faces with cosmetics (Killian and Peissig, 2013).

The contrast pattern of the eyes and brows influencing perceptions of sex typicality has been hinted at elsewhere. Dupuis-Roy et al. (2009) showed that the brow-eye region, especially the luminance properties of these features, is important for classifying face sex. Observers are able to rely on this pattern even in the absence of other color cues to sex. Importantly, the shape or brow-eye distance did not predict sex classification, with color information proving more reliable. We extend these findings by showing the sexual dimorphism in contrast in the upper face region is consistently different between males and females, and is a pattern manipulated by cosmetics. Additionally, these findings offer some support to the suggestion of Stephen et al. (2009) who stated that the effects of facial contrast on femininity and masculinity (Russell, 2009) are due to contrast around the eyes more than the contrast around the mouth. We observed a larger effect of cosmetics on the eyes than the mouth ($d = 1.46$, $d = 0.32$, respectively), a finding consistent with the results of our meta-analysis of the size of the sex difference of these contrasts. The effect size of an application of cosmetics was also greater across the eyes than any other feature, regardless of the color channel, indicating amore extensive manipulation of this feature. Indeed, the effect size for eye luminance contrast ($d = 1.46$) was greater than any observed

natural sex difference in contrast of this feature ($d = 0.62$, 1.25, and 0.96 for Sets 1, 2, and 3, respectively). These findings may also explain why eye makeup alone increases attractiveness, while mouth makeup fails to do so (Mulhern et al., 2003). Further, the findings here contradict the alternative suggestion of Stephen et al. (2009), who suggested the use of black and white images removes important color information when examining sexual dimorphism in facial contrast. By examining contrasts in all channels in Experiment 1, we found no consistent evidence of sexual dimorphism in eye or mouth contrasts in color channels other than the luminance ($L*$) channel.

These findings advance our knowledge of female mate value and mate attraction techniques. Female mate value is tied to physical attractiveness, which itself is strongly linked to sexual dimorphism (i.e., femininity; O'Toole et al., 1999; Rhodes, 2006). Given that the use of cosmetics by women enhances their facial contrast, making them appear more feminine, it is unsurprising that women use cosmetics as a primary method of enhancing appearance for initiating relationships (Greer and Buss, 1994), and receive more male attention when wearing cosmetics (Guéguen, 2008). The above evidence might suggest that cosmetics function as supernormal stimuli, exaggerating feminine traits. In non-human animals, exaggerated sexual characteristics, such as lengthened tails (Winquist and Lemon, 1994), lead to greater mating success. Though the lack of a sex difference in mouth contrast was surprising, and does not support the notion that cosmetics serve to enhance sexually dimorphism in facial contrast, the present results confirm that cosmetics can serve to make female faces appear supernormal by exaggerating attractive contrasts (e.g. reddened lips, Stephen and McKeegan, 2010). These findings indicate cosmetics can increase attractiveness by acting on multiple facial signal channels, such as those of youth and femininity.

Including the eyebrow as a source of contrast in the current experiments showed this region is sexually dimorphic. By examining the eyes and eyebrows separately, we now find this area contains two different cues to dimorphism. However, it may be that because the majority of females modify their eyebrows via plucking or trimming, there is likely a cultural component that may be responsible for the sexual dimorphism observed here. Data from a sample of faces in which eyebrows are not modified as part of a standard beauty practice would help clarify whether the dimorphism we observed is natural or artificial. However, reduced brow thickness is associated with increased attractiveness (Kościński, 2012), regardless of the nature of the manipulation, and this reduction may be furthered by cosmetics.

While lowered contrast in female eyebrows might enhance a desirable dimorphism, it may also enhance a potentially undesirable signal of aging. Women might therefore be expected to use cosmetics for the eyebrows strategically, to either emphasize femininity on one hand, or something like energy and vigor on the other. However, popular cosmetic trends at the time of writing advise darkening of the brows, likely because contrast of the brow decreases with age. However, this may be more beneficial for older women (as are most cosmetic practices; see Huguet, Croizet, and Richetin, 2004) - younger woman may appear more masculine as a result of adopting this practice. A similar conflict may have led to the increase in the yellow-blue contrasts of the mouth, which increase with age and were also increased by cosmetics. However, as stated, this may be due to contrast changes being brought about by foundations increasing the yellowness of the skin, a cue to health (Stephen, Coetzee, and Perrett, 2011).

The present study has several limitations. First, the lighting and camera conditions were not constant across the image sets used in Experiment 1, and so we were unable to compare the differences between image sets due to the lighting and camera differences, which affect the color properties of the images. However, this is also a strength of the study. The sex differences in facial contrast of the eyes and brow were consistent across varying lighting and camera scenarios, indicating a robust effect that is not susceptible to variance in image properties. Second, we instructed females in Experiment 2 to apply cosmetics as if they were going on a "night out", and so our findings apply to the cosmetics used in this context, and may differ from other makeup styles (e.g., day to day, job interview). However, other literature has shown consistent increases in facial contrast for a range of different makeup styles (Etcoff et al., 2011), so it is likely our results generalize to the majority of cosmetics contexts, though the strength of the manipulation may vary under different circumstances. The lack of color calibration in our images could be viewed as problematic. Studies investigating one dimensional color properties of surfaces such as faces require color calibration of the images (Stephen et al., 2009). However, as our variable of interest (facial contrast) is a relative measure of color properties within the same image, the issue of color calibration is less relevant here. Additionally, the application of cosmetics led to contrast changes. While the luminance channel differences are consistent with previous work (Russell, 2009) and our own results, the $a*$ and $b*$ channel contrast changes could be caused by the limited range of cosmetics that were provided. Despite this, there were consistent similarities with the contrast changes with age described by Porcheron et al. (2013), in that feature contrasts that decrease with age seem to be enhanced by cosmetics.

Conclusions

We have shown that feature contrasts of the eyes and brows diverge in a consistent pattern between sexes, with females having greater luminance contrast of the eyes, but lower luminance contrast of the eyebrows. Women who applied cosmetics did so in a way that exaggerated these sex differences in feature contrasts. Cosmetics also increased feature contrasts that decline with age, as well as contrasts that are associated with increased attractiveness and femininity, demonstrating the action of cosmetics on multiple signal channels in the face. These findings further our understanding of the biological bases of beauty by refining the notion of facial contrast and offer further explanation of how cosmetics beautify faces.

References

Aucoin, K. (1997). *Making faces.* Boston, MA: Little, Brown.

Baldevbhai, P. J., and Anand, R. S. (2012). Color image segmentation for medical images using L*a*b* color space. *IOSR Journal of Electronics and Communication Engineering, 1*, 24-45.

Beall, A. T., and Tracy, J. L. (2013). Women are more likely to wear red or pink at peak fertility. *Psychological Science, 24*, 1837-1841.

Buss, D. M. (1988). The evolution of human intrasexual competition: Tactics of mate attraction. *Journal of Personality and Social Psychology, 54*, 616-628.

Buss, D. M. (1994). The strategies of human mating. *American Scientist, 82*, 238-249.

Cash, T. F., Dawson, K., Davis, P., Bowen, M., and Galumbeck, C. (1989). Effects of cosmetics use on the physical attractiveness and body image of American college women. *Journal of Social Psychology, 129*, 349-355.

Corson, R. (1972). *Fashions in makeup: From ancient to modern times.* London: Peter Owen.

Deschner, T., Heistermann, M., Hodges, K., and Boesch, C. (2004). Female sexual swelling size, timing of ovulation, and male behavior in wild West African chimpanzees. *Hormones and Behavior, 46*, 204-215.

Dixson, A. F., and Herbert, J. (1977). Gonadal hormones and sexual behavior in groups of adult talapoin monkeys (*Miopethicus talapoin*). *Hormones and Behavior, 8*, 141-154.

Dupuis-Roy, N., Fortin, I., Fiset, D., and Gosselin, F. (2009). Uncovering gender discrimination in a realistic setting. *Journal of Vision, 9*, 1-8.

Elliot, A. J., and Niesta, D. (2008). Romantic red: Red enhances men's attraction to women. *Journal of Personality and Social Psychology, 95*, 1150-1164.

Etcoff, N. L., Stock, S., Haley, L. E., Vickery, S. A., and House, D. M. (2011). Cosmetics as a feature of the extended human phenotype: Modulation of the perception of biologically important facial signals. *PLOS ONE, 6*, e25656.

Farkas, L. G. (1987). Age and sex related changes in facial proportions. In L. G. Farkas and I. R. Munro (Eds.), *Anthropometric facial proportions in medicine.* Springfield, IL: Charles C Thomas.

Farkas, L. G., and Munro, I. R. (Eds.). (1987). *Anthropometric facial proportions in medicine.* Springfield, IL: Charles C Thomas.

Field, A. P. (2005). Meta-analysis. In J. Miles and P. Gilbert (Eds.), *A handbook of research methods in clinical and health psychology* (pp. 295-308). Oxford: Oxford University Press.

Frost, P. (2005). *Fair women, dark men.* Christchurch, New Zealand: Cybereditions Corporation.

Geisler, W. S., Albrecht, D. G., and Crane, A. M. (2007). Responses of neurons in primary visual cortex to transient changes in local contrast and luminance. *Journal of Neuroscience, 27*, 5063-5067.

Greer, A., and Buss, D. M. (1994). Tactics for promoting sexual encounters. *The Journal of Sex Research, 5*, 185-201.

Guéguen, N. (2008). The effects of women's cosmetics on men's approach: An evaluation in a bar. *North American Journal of Psychology, 10*, 221-228.

Guéguen, N. (2012a). Color and women attractiveness: When red clothed women are perceived to have more intense sexual intent. *The Journal of Social Psychology, 152*, 261-265.

Guéguen, N. (2012b). Makeup and menstrual cycle: Near ovulation, women use more cosmetics. *Psychological Record, 62*, 541-548.

Hill, H., Bruce, V., and Akamatsu, S. (1995). Perceiving the sex and race of faces: The role of shape and color. *Proceedings of the Royal Society of London, B: Biological Sciences, 261*, 367-373.

Huguet, P., Croizet, J-C., and Richetin, J. (2004). Is "what has been cared for" necessarily good? Further evidence for the negative impact of cosmetics use on impression formation. *Journal of Applied Social Psychology, 34*, 1752-1771.

International Color Consortium (2004). *Specification ICC.1:2004-10. Image technology colour management – Architecture, profile format, and data structure*. Retrieved from www.color.org/ICC1v42_2006-05.pdf

Jablonski, N. G. and Chaplin, G. (2000). The evolution of human skin coloration. *Journal of Human Evolution, 39*, 57-106.

Jones, A. L., and Kramer, R. S. S. (2015). Facial cosmetics have little effect on attractiveness judgements compared with identity. *Perception, 44*, 79-86.

Jones, A. L., Kramer, R. S. S., and Ward, R. (2014). Miscalibrations in judgements of attractiveness with cosmetics. *Quarterly Journal of Experimental Psychology, 67*, 2060-2068.

Jones, D. (1996). *Physical attractiveness and the theory of sexual selection: Results from five populations.* Ann Arbor, MI: Museum of Anthropology Press, University of Michigan.

Killian, A. C., and Peissig, J. J. (2013). Regional differences in the effects of makeup on attractiveness. *Journal of Vision, 13*, 852.

Kościński, K. (2012). Hand attractiveness – its determinants and associations with facial attractiveness. *Behavioral Ecology, 23*, 334-342.

Mulhern, R., Fieldman, G., Hussey, T., Lévêque, J. -L., and Pineau, P. (2003). Do cosmetics enhance female Caucasian facial attractiveness? *International Journal of Cosmetic Science, 25*, 199-205.

Nash, R., Fieldman, G., Hussey, T., Lévéque, J. -L., and Pineau, P. (2006). Cosmetics: They influence more than Caucasian female facial attractiveness. *Journal of Applied Social Psychology*, *36*, 493-504.

Nestor, A., and Tarr, M. J. (2008). Gender recognition of human faces using color. *Psychological Science, 19*(12), 1241-1246.

Niesta Kayser, D., Elliot, A. J., and Feltman, R. (2010). Red and romantic behavior in men viewing women. *European Journal of Social Psychology, 40,* 901-908.

O'Toole, A. J., Price, T., Vetter, T., Bartlett, J. C., and Blanz, V. (1999). 3D shape and 2D surface textures of human faces: The role of "averages" in attractiveness and age. *Image and Vision Computing, 18*, 9-19.

Perrett, D. I., Lee, K. J., Penton-Voak, I. S., Rowland, D. R., Yoshikawa, S., Burt, D. M., . . . Akamatsu, S. (1998). Effects of sexual dimorphism on facial attractiveness. *Nature, 394*, 884-887.

Porcheron, A., Mauger, E., and Russell, R. (2013). Aspects of facial contrast decrease with age and are cues for age perception. *PLOS ONE, 8*, e57985.

Regas, J. C., and Kozlowski, K. (1998). *Read my lips: A cultural history of lipstick*. San Francisco: Chronicle Books.

Rhodes, G. (2006). The evolutionary psychology of facial beauty. *Annual Review of Psychology, 57*, 199-226.

Russell, R. (2003). Sex, beauty, and the relative luminance of facial features. *Perception, 32*, 1093-1107.

Russell, R. (2009). A sex difference in facial contrast and its exaggeration by cosmetics. *Perception, 38*, 1211-1219.

Russell, R. (2010). Why cosmetics work. In R. B. Adams, A. Ambady, K. Nakayama, and S. Shimojo (Eds.), *The science of social vision* (pp. 186-204). Oxford: Oxford University Press.

Samson, N., Fink, B., and Matts, P. J. (2010). Visible skin condition and perception of human facial appearance. *International Journal of Cosmetic Science, 32*, 167-184.

Shackelford, T. K., and Larsen, R. L. (1999). Facial attractiveness and physical health. *Evolution and Human Behavior, 20*, 71-76.

Singh, D. (2004). Mating strategies of young women: Role of physical attractiveness. *The Journal of Sex Research, 41*, 43-54.

Sinha, P. (2002). Qualitative representations in for recognition. *Lecture Notes in Computer Science, 2525*, 249-262.

Stephen, I. D., Coetzee, V., and Perrett, D. I. (2011). Carotenoid and melanin pigment coloration affect perceived human health. *Evolution and Human Behavior, 32*, 216-277.

Stephen, I. D., Law-Smith, M. J., Stirrat, M. R., and Perrett, D. I. (2009). Facial skin coloration affects perceived health of human faces. *International Journal of Primatology, 30*, 845-857.

Stephen, I. D., and McKeegan, A. M. (2010). Lip color affects perceived sex typicality and attractiveness of human faces. *Perception, 39*, 1104-1110.

Thornhill, R., and Gangestad, S. W. (2006). Facial sexual dimorphism, developmental stability, and susceptibility to disease in men and women. *Evolution and Human Behavior, 27*, 131-144.

Tiddeman, B. P., Burt, D. M., and Perrett, D. I. (2001). Prototyping and transforming facial textures for perception research. *IEEE Computer Graphics and Applications, 21*, 42-45.

Weatherall, I. L., and Coombs, B. D. (1992). Skin color measurements in terms of CIELAB color space values. *Journal of Investigative Dermatology, 99*, 468-73.

Winquist, T., and Lemon, R. E. (1994). Sexual selection and exaggerated male tail length in birds. *The American Naturalist, 143*, 95-116.