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Makeup Changes the Apparent Size of Facial Features

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Makeup is a prominent example of the universal human practice of personal decoration. Many studies have shown that makeup makes the face appear more beautiful, but the visual cues mediating this effect are not well understood. A widespread belief holds that makeup makes the facial features appear larger. We tested this hypothesis using a novel reference comparison paradigm, in which carefully controlled photographs of faces with and without makeup were compared with an average reference face. Participants compared the relative size of specific features (eyebrows, eyes, nose, mouth) of the reference face and individual faces with or without makeup. Across three studies we found consistent evidence that eyes and eyebrows appeared larger with makeup than without. In contrast, there was almost no evidence that the lips appeared larger with makeup than without. In two studies using professionally applied makeup the nose appeared smaller with makeup than without, but in a study using self-applied makeup there was no difference. Thus makeup was found to alter the facial feature sizes in ways that are related to age and sex, two known factors of beauty. These results provide further evidence to support the idea that makeup functions in part by modifying biologically based factors of beauty.

Keywords: beauty, makeup, cosmetics, attractiveness, face perception

Decorating the face and body is a universal human behavior occurring across cultures (Brown, 1991). Evidence of body painting has been found very early in the human archeological record (Jablonski, 2006), making it one of the earliest and most widespread varieties of aesthetic practice. Although many different forms of face and body decoration exist globally (Brain, 1979), in industrialized societies the use of facial cosmetics is one of the most prominent examples of body art. In the West, historical records indicate that makeup has been used prominently for thousands of years (Corson, 1972). In the present day, over 80% of women aged 18 or above use cosmetics (Etcoff, 1999). This aesthetic effort does not go unrewarded. In controlled experimental studies, faces wearing makeup are perceived as having higher social status (Mileva, Jones, Russell, & Little, 2016; Nash, Fieldman, Hussey, Leveque, & Pineau, 2006; Richetin, Croizet, & Huguet, 2004), being more attractive (Cash, Dawson, Davis, Bowen, & Galumbeck, 1989; Etcoff, Stock, Haley, Vickery, & House, 2011; Graham & Jouhar, 1981; Jones & Kramer, 2015; Mileva et al., 2016; Mulhern, Fieldman, Hussey, Lévêque, & Pineau, 2003) and causing greater increases in the activation of reward centers in the brain (Ueno et al., 2014). In naturalistic field experiments makeup has been found to increase attractiveness and to elicit other positive behaviors (Guéguen, 2008; Guéguen & Jacob, 2011; Guéguen & Lamy, 2013). It is clear that the effort that goes into decorating the face with cosmetics yields tangible benefits for the wearer.

Recent work has begun to explore the nature of the visual features that are modified by makeup to make the face appear more attractive. Skin homogeneity (evenness of skin tone) is presumably modified by cosmetics and is related to looking more attractive, as well as younger and healthier (Fink, Grammer, & Matts, 2006; Matts, Fink, Grammer, & Burquest, 2007; Samson, Fink, & Matts, 2010). Another important cue modified by cosmetics is facial contrast—the difference in coloration between facial features and the surrounding skin. Cosmetics increase facial contrast (Etcoff et al., 2011; Jones, Russell, & Ward, 2015; Russell, 2009; Stephen & McKeegan, 2010), and female faces with higher contrast are perceived as more attractive (Russell, 2003; Stephen & McKeegan, 2010; Störmer & Alvarez, 2016). Facial contrast is naturally higher in female faces than in male faces (Jones et al., 2015; Russell, 2009), due to females having lighter skin than males (Frost, 2005), but not lighter eyes or lips. Other aspects of facial contrast decrease with age and are cues for perceiving age from the

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face (Porcheron, Mauger, & Russell, 2013). Increasing contrast makes faces appear younger, and many of the aspects of facial contrast that decline with age are increased by cosmetics (Jones et al., 2015). Higher facial contrast also looks healthier (Russell et al., 2016), and makeup increases those aspects of facial contrast responsible for looking healthy (Jones et al., 2015). Makeup also modifies the color of other facial regions that are implicated in perceived health, such as the area under the eyes and the cheeks (Jones, Porcheron, Sweda, Morizot, & Russell, 2016). Consistent with this, faces wearing makeup are perceived as healthier (Nash et al., 2006).

In addition to modifying the apparent surface reflectance properties of the skin, might there be other visual factors that mediate the increase in attractiveness caused by makeup? The apparent size of the facial features is widely believed to be affected by makeup, and several authors have proposed that makeup functions in part by making the eyes (Morris, 1977; Perrett, 2010; Zebrowitz, 1997) or the lips (Bruce & Young, 1998; Morris, 2002; Zebrowitz, 1997) appear larger to make the face appear more feminine or youthful. Indeed, female faces with larger facial features such as the eyes and lips are considered more attractive (Chen, Russell, Nakayama, & Livingstone, 2010; Cunningham, Barbee, & Pike, 1990; Geldart, Maurer, & Carney, 1999; McArthur & Apatow, 1984; Perret, May, & Yoshikawa, 1994). The attractiveness of large eyes and lips is believed to be due to two factors. First, large features are more sex-typical of female faces (Bruce & Young, 1998). Second, large features appear youthful (Cunningham, 1981; Zebrowitz, 1997). In older adulthood, sagging skin around the eyes reduces the size of the eyes, and lips become less defined (Burt & Perrett, 1995; George & Hole, 1995; Samson, Fink, Matts, Dawes, & Weitz, 2010). These findings are reflected in contemporary cosmetic practices—beauty manuals offer detailed instructions on how to increase the size or alter the shape of the mouth using lipstick, or to create rounder, fuller eyes using a variety of products such as eyeshadow and eyeliner (Aucoin, 1997, 2000). In recent history, 'big eye' styles of cosmetics have been popular, especially during the 1950s (Peiss, 1998).

Despite the widely held belief that makeup makes the eyes and lips look larger, the idea has received almost no scientific evaluation. Recently, Morikawa and colleagues used psychophysical methods to test whether the eyes appear larger when wearing eyeshadow (Morikawa, Matsushita, Tomita, & Yamanami, 2015). They found that faces wearing eyeshadow appear to have larger eyes, and that the effect is moderated by the distance between the eyes and the eyebrows, as well as by the viewing distance from the face. To date, this is the only study examining how cosmetics alter the perceived size of facial features.

Here we sought to more broadly test the effect of makeup on the perceived size of facial features, by investigating how multiple facial features would be affected by full-face makeup. To explore how makeup changes the apparent size of the feature, we examined the effects makeup has on perceived feature size at different spatial frequencies, particularly those frequencies above or below 10 cycles per face width, the range that is most important for face perception (Näsänen, 1999). In this way, we tested whether the change of apparent size of the features was due to the alteration of coarse information or of fine details.

To do this, we devised a novel reference comparison paradigm, and across three studies tested the hypothesis that makeup makes the eyes and mouth look larger. We also predicted that the apparent size of the nose should remain unchanged when makeup was self-applied, but that it would appear smaller when professionally applied. Makeup artists commonly employ techniques such as 'contouring' that are believed to affect the apparent shapes of features such as the nose. We used two different samples of carefully controlled photographs of the same women with and without makeup to examine these questions. Our reference comparison paradigm involved averaging all the photographs in each sample, of the faces both with and without makeup, to create a single image that served as the reference face. In each trial, participants were shown the reference face next to an unmanipulated photograph of an individual woman, either with or without makeup. The participants' task was to indicate whether the reference face or the target face had the larger feature (e.g., eyes), and by how much. To do this, participants used a sliding scale located directly below the faces, with a 'no difference' midpoint between the two. To test our hypothesis, we compared the size ratings given to the same target faces with and without makeup. The first study asked participants to make size ratings of the eyes, nose, and lips, using a set of faces with self-applied makeup. The second study replicated these results using a different set of faces that were made up by a professional makeup artist, and also included size ratings of the eyebrows. Finally, the third study sought to explore the cause of the effect of makeup on feature size by applying a technique common in vision science—spatial frequency filtering—and asking participants to make ratings of faces that had been spatially filtered to include only low spatial frequencies (i.e., coarse information) or high spatial frequencies (i.e., fine details).

Study 1

Method

The participant recruitment and experimental procedures for all of the studies were approved by the Gettysburg College Institutional Review Board.

Models. A sample of 44 female students at Bangor University (age $M = 21.18$ years, $SD = 1.94$) participated as models, as described in Jones et al. 2015, Experiment 2. All of these models self-reported as being of White ethnicity, agreed to have their likeness shown in experiments, and were paid £6 for their participation. Models were photographed twice, once without their makeup, and once after self-applying a range of cosmetics that were provided. Models were photographed with a Nikon D3000 SLR camera at a distance of approximately one meter against a white background in a windowless room with overhead lighting and a Nikon SS-400 flash angled 45° toward the ceiling. For the initial photograph, models were asked to remove all traces of facial jewelry, tie their hair back from their face, thoroughly clean their face of all cosmetic products, and to adopt a neutral expression. Following the initial photograph, participants were presented with a range of cosmetics, including foundation, lipstick, eyeshadow, mascara, and blusher, and were asked to apply cosmetics as if they were going on a 'night out.' They were subsequently photographed with their cosmetics. Between photographs, all camera settings were kept constant.

Reference face generation. We added a series of 160 landmarks to each model, in both cosmetics conditions, using JPsychomorph (Tiddeman, Burt, & Perret, 2001). We then averaged the

88 images (of 44 models in two cosmetics conditions) to provide a single reference face for both cosmetics conditions. In this way, the reference face represented the average appearance of the models both with and without cosmetics.

Participants. Sixty-six Gettysburg College students (41 females, age $M = 19.14$ years, $SD = 1.02$) participated for partial course credit as part of an introductory psychology class. Participants were informed they were taking part in a study investigating the basics of face perception, and were fully debriefed at the end of study. Participants took part during a spring term, with data being collected for the duration of this period.

Procedure. For each trial, participants viewed a pair of images on screen, a "reference face" on the left, and a "target face" on the right. An example trial is shown in Figure 1. The reference face for each trial was the average face of the models across both cosmetics conditions, and the target face was one of the 44 models in one of the two cosmetics conditions. For each target, participants were asked to compare the size of facial features between the pairs of faces, by indicating which face, and to what extent, had the larger facial features. Participants judged one feature at a time, in the order of the eyes, nose, then mouth. The current feature to compare was stated at the top of the screen with the question, "Which face, and by how much, has the larger eyes/nose/mouth?" Participants indicated their response by using the mouse to adjust a sliding scale underneath the faces. The scale was labeled, "This face has a much larger feature" at the left and right side and with "About the same" in the center. Moving the scale to the right, toward the target face, indicated participants thought the target face had a larger feature, and they assigned a score from 1 to 50 via adjusting the scale. Conversely, moving the scale to the left, toward the reference face, indicated participants thought the reference face had a larger feature, and scores were assigned from −1 to −50. A score of 0 indicated that feature looked the same size in both faces. Participants completed a total of 132 trials, with three features being compared for each of the 44 models. Models were presented in a random order for each participant. Importantly, participants were assigned in a counterbalanced order to one of two presentation conditions—they either compared the features of the models without cosmetics ($n = 33$) or with self-applied cosmetics ($n = 33$) in order to prevent any indication of the manipulation. Stimuli were resized for display to a height of 600 pixels. Custom Python software was written using PsychoPy to present stimuli and collect responses (Peirce, 2007).

Figure 1. An example of an experimental trial in the makeup condition. Participants indicated their responses by adjusting the sliding scale. See the online article for the color version of this figure.

Analytic approach. For this study (and all subsequent studies presented here) we treated the items (i.e., the target faces/models) as the unit of analysis, by computing an aggregate perceived size score for each facial feature, under each cosmetics condition, by averaging trials across participants. We use faces as the object of study, as we wish to make statistical inferences about how cosmetics might affect faces in general, rather than the perceptions of observers. It is also common practice to use faces as the unit of analysis when examining how attributes of faces may affect social perceptions (Jones & Kramer, 2016; Rhodes, Sumich, & Byatt, 1999; Rhodes et al., 2007). However, it is important to note that according to generalizability theory (Cardinet, Tourneur, & Allal, 1981), designs such as this are essentially symmetrical, and which facet to use as the object of analysis is a conceptual decision.

Results

For each model, we computed an average perceived size score for each feature under each cosmetics condition by averaging across participants, yielding six scores per model. These scores, averaged across all the models, are shown in Figure 2. We sought to examine the effect of cosmetics on the perceived sizes of the facial features. To do this, we used a 3 (feature: eyes, nose, mouth) × 2 (cosmetics: without, with) repeated-measures analysis of variance (ANOVA) on the average scores for each model.

There was a significant interaction between feature and cosmetics, $F(2, 86) = 11.44$, $p < .001$, $\eta_p^2 = .21$, indicating the presence of cosmetics affected the perceived size of features differently. This interaction qualified a main effect of feature, $F(2, 86) = 7.15$, $p = .001$, $\eta_p^2 = .14$, that indicated that there was variation among the features in terms of the relative sizes of the reference face and the target faces. For example, it can be readily seen in Figure 2 that the target noses were perceived as larger on average than the reference nose, but there was no such difference for the mouth. There was also a main effect of cosmetics, $F(1, 43) = 10.71$, $p = .002$, $\eta_p^2 = .20$, with the features being perceived as larger with cosmetics ($M = 3.31$, 95% CI [1.12, 5.51]) than without, ($M = 2.20$, 95% CI [−0.14, 4.54]). Post hoc comparisons revealed the interaction between feature and cosmetics was driven by the eye feature having been perceived as significantly larger with cosmetics ($M = 6.97$, 95% CI [4.14, 9.81]) than without ($M = 3.50$, 95% CI [0.13, 6.86]), $t(43) = 4.97$, $p < .001$, $d = 0.75$, whereas there was no difference in perceived size for the nose, $t(43) = 0.91$, $p = .369$, $d = 0.14$ (without $M = 4.07$, 95% CI [1.39, 6.76]; with $M = 3.66$, 95% CI [0.91, 6.40]), or the

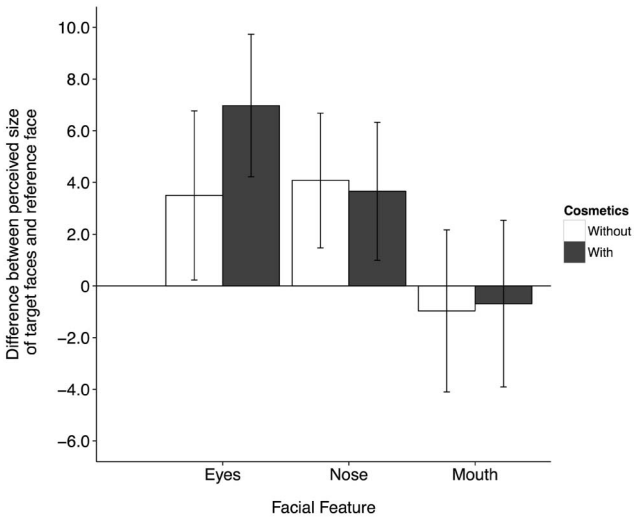

Figure 2. The difference between perceived size of the features in the target faces and in the reference face. Positive values indicate that the target feature was perceived to be larger, on average, than the reference feature. Error bars represent 95% confidence intervals. Target face eyes were perceived as larger than the reference face eyes, but were perceived as even larger when cosmetics were applied. Although target face noses appeared larger than the reference faces noses, there was no effect of cosmetics. Target face mouths did not differ from the reference face mouths, and were also unchanged by cosmetics.

mouth, $t(43) = 0.45$, $p = .659$, $d = 0.06$ (without $M = -0.97$, 95% CI [−4.19, 2.26]; with $M = -0.68$, 95% CI [−4.00, 2.63]).

Discussion

We tested the prediction that cosmetics would make the eyes and lips look larger, but have no effect on the apparent size of the nose. As predicted, cosmetics did not change the apparent size of the nose. We did find evidence that cosmetics made the eyes look larger, but did not find that cosmetics made the mouth look larger. The finding that cosmetics made the eyes appear larger is consistent with other recent work that found that eye shadow increases perceived eye size (Morikawa et al., 2015). The lack of an effect of makeup on perceived mouth size was unexpected, as this effect has been proposed by several theorists (Bruce & Young, 1998; Morris, 2002; Zebrowitz, 1997). However, if the change in apparent feature size is one of the ways that makeup makes faces appear more attractive, the finding that makeup makes eyes but not mouths look larger would help explain the observation that eye makeup alone is sufficient to increase perceived attractiveness, but lip makeup alone is not sufficient (Mulhern et al., 2003).

Study 2

In Study 2 we sought to test the generalizability of the findings from Study 1 by varying four attributes of the experiment. First, we used target faces with a larger age range, as the set used in Study 1 were young with little variance in age. However, cosmetics seem to offer the most beneficial changes to facial appearance in older women (Huguet, Croizet, & Richetin, 2004), and since the sizes of facial features decline with age (Samson, Fink, Matts, et al., 2010), the effect of cosmetics on perceived feature size may be larger in older women. Second, we used a group of participants who were somewhat older and more variable in terms of their age. This was done to more closely match the age of the participants to the age of the target faces and more generally because the age of the participant may be relevant to the effect of makeup on face perception. For example, there are different effects of makeup on person perception among university students in different programs of study (Richetin et al., 2004), and it is possible that that participant age similarly moderates effects of makeup on perception. Third, we had a professional makeup artist apply the cosmetics. It may be that increasing the perceived size of certain facial features requires skills that the models in Study 1 (very young women who applied their own makeup) did not possess. Finally, we added the eyebrow to the list of features examined, as it is also commonly altered by cosmetics, and brow contrasts decrease with age, making brows less visible (Porcheron et al., 2013). Brow contrasts are also sexually dimorphic, being higher in male faces (Jones et al., 2015), and brow thickness, which can be modified by cosmetics or plucking, is also related to attractiveness (Koœciński, 2012). Eyebrows are also implicated in gender recognition (Dupuis-Roy, Fortin, Fiset, & Gosselin, 2009), in perception of facial expression (Fox et al., 2000), and in face recognition (Sadr, Jarudi, & Sinha, 2003).

We predicted that eyes would appear larger with cosmetics as in Study 1. Despite finding no difference in apparent mouth size in Study 1, we again predicted that the mouth would appear larger in Study 2, for the reason that that the greater skill of the makeup artist would yield an application of makeup that was more effective in changing the apparent feature sizes. Also for that same reason we predicted a difference in the perceived size of the nose, as greater skill in applying cosmetics opens up the possibility of a reduction in the apparent size of the feature by means of 'contouring.' We had no strong hypothesis regarding the effect of makeup on perceived eyebrow size, but given the existence of cosmetic products like brow pencils, we hypothesized an increase in perceived brow size.

Method

Models. A separate sample of 32 Caucasian women (age $M = 32.50$ years, $SD = 11.14$) recruited in Paris, France by a recruitment company participated as models. All models were paid €40 for their participation as part of a wider range of data collection activities, and agreed to have their likeness shown in experiments. As before, models were photographed twice, once without cosmetics, and once with. Models were photographed using a Canon EOS-1 Ds MII camera, using a diffuse light in front of the face, with direct flashes placed at 45° on either side of the face. Models were asked to maintain a neutral expression, remove any jewelry, and wore hairnets to remove their hair from the face. For the first photograph, participants removed all traces of cosmetics. For the second exposure, participants were photographed after having cosmetics applied by a professional makeup artist. The makeup artist was instructed simply to make the faces more beautiful, and was blind to the hypothesis of this study. As before, camera settings were kept constant between photographs.

Reference face generation. As in Study 1, we added a series of 160 landmarks to each model in both cosmetics conditions, and

averaged all 64 images (of the 32 models in two cosmetics conditions) to create a reference image by averaging together all the faces across both cosmetics conditions.

Participants. Thirty-five nonstudent members of the Gettysburg College community (26 females, age $M = 38.88$ years, $SD = 14.36$) participated in the study and were paid $10. Participants were recruited using an electronic notice board, and were informed they were taking part in a study investigating the basics of face perception, and were fully debriefed at the end of the study. This sample of participants was collected over the summer months, and data collection continued for the duration of this period.

Procedure. The procedure utilized for this experiment was the same as used in Study 1, except for the addition of the eyebrow as a feature. As such, participants judged four facial features for each of the 32 models, in the order of eyebrows, eyes, nose, and mouth, for a total of 128 trials. Participants were again assigned in a counterbalanced order to either the without cosmetics condition ($n = 17$) or the with cosmetics condition ($n = 18$). Stimuli were resized for display to a height of 600 pixels.

Results

The results are shown in Figure 3. We used the same analytic approach as in Study 1, using the model as the unit of analysis by averaging ratings across participants to provide eight scores per face, one for each feature under each cosmetics condition. We examined the changes in the perceived sizes of facial features with cosmetics using a 4 (feature: brows, eyes, nose, mouth) × 2 (cosmetics: without, with) repeated-measures ANOVA on the average scores for each model in each cosmetics condition.

There was an interaction between feature and cosmetics, $F(3, 93) = 26.39$, $p < .001$, $\eta_p^2 = .46$, indicating that the presence of cosmetics affected the perceived size of features differently. The interaction qualified a main effect of cosmetics, $F(1, 31) = 22.69$, $p < .001$, $\eta_p^2 = .42$, with features being generally larger with cosmetics ($M = 0.77$, 95% CI [−1.36, 2.91]) than without ($M = -2.12$, 95% CI [−4.81, 0.57]). Unlike in Study 1, in Study 2 there was no main effect of feature, indicating that there was not significant variation among the features in terms of the relative perceived sizes of the reference face and the target faces $F(3, 93) = 1.12$, $p = .345$, $\eta_p^2 = .04$.

Comparisons between cosmetics conditions for each figure revealed the interaction was driven by several differences. Eyebrows appeared larger with cosmetics ($M = 0.56$, 95% CI [−4.23, 5.36]) than without ($M = -6.48$, 95% CI [−12.38, −0.60]), $t(31) = 6.63$, $p < .001$, $d = 1.17$, as did eyes (without, $M = -2.57$, 95% CI [−6.74, 1.60]; with, $M = 2.76$, 95% CI [−0.94, 6.46]), $t(31) = 5.66$, $p < .001$, $d = 0.99$. The perceived size of noses significantly decreased with cosmetics ($M = 0.37$, 95% CI [−2.41, 3.17]) compared with without cosmetics ($M = 2.38$, 95% CI [−0.94, 5.71]), $t(31) = 2.52$, $p = .017$, $d = 0.45$. For the perceived size of the mouth there was no difference, $t(31) = 1.42$, $p = .165$, $d = 0.02$, between cosmetics conditions (without, $M = -1.81$, 95% CI [−5.29; 1.67]; with, $M = -0.60$, 95% CI [−3.45, 2.25]).

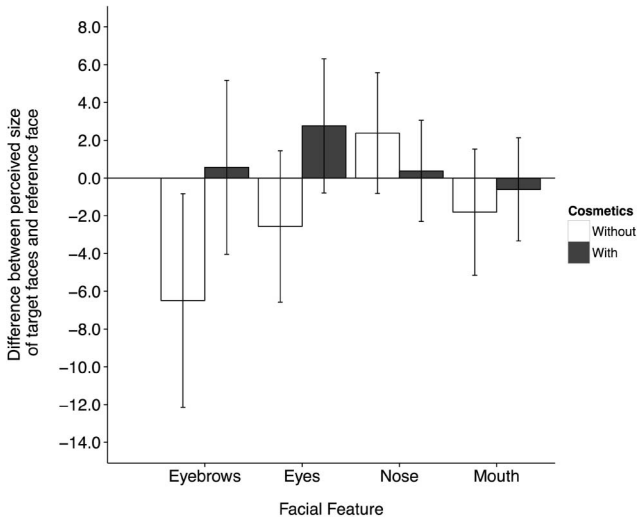

Figure 3. The difference between perceived size of the features in the target faces and in the reference face. Positive values indicate that the target feature was perceived to be larger on average than the reference feature. Error bars represent 95% confidence intervals. Eyebrows and Eyes were perceived as significantly larger with cosmetics than without. In contrast, the nose appeared smaller with cosmetics than without. The apparent size of the mouth was unchanged by cosmetics.

Discussion

A further investigation of the effect of cosmetics on perceived size of facial features revealed some consistent and some novel findings. We investigated the apparent size of the eyebrows, and found that they appeared larger with cosmetics than without. Eyes appeared larger with cosmetics than without cosmetics, consistent with Study 1 and other work (Morikawa et al., 2015). However, unlike in Study 1, noses appeared smaller with cosmetics then without. We attribute this difference between the studies to the use of a professional makeup artist in Study 2. After the study was completed the makeup artist indicated that he did use 'contouring' when he made up the faces. This technique involves applying darker and lighter foundations to different areas of the face, to change the apparent three-dimensional structure of the face, and operates on the same principle as chiaroscuro techniques from painting or shape from shading algorithms from computer vision. Finally, we again observed no difference in perceived mouth size with cosmetics, consistent with the findings of Study 1.

Study 3

The findings from Studies 1 and 2 provided clear evidence that makeup modifies apparent feature size, though in different ways for different features. Across both studies the eyes were perceived as larger with makeup than without, consistent with the findings of Morikawa et al. (2015). In both studies the lips were perceived as no different in size with or without makeup. In contrast, the nose was perceived as smaller with makeup, but only in Study 2, which used a professional makeup artist. The eyebrows were only tested in Study 2, and were perceived as larger. But how does makeup change the apparent size of certain features? In Study 3 we investigate whether makeup operates on particular spatial frequencies to change apparent feature size.

Contrast within an image can be described in terms of its spatial frequency. High spatial frequencies convey fine detail, whereas

low spatial frequencies convey coarse information. Psychophysical studies have established that humans rely on a narrow band of spatial frequencies to recognize faces, specifically in the range of 8 to 16 cycles per face width (see reviews by Ruiz-Soler & Beltran (2006), and Keil (2008)). It has been argued that the bias toward these spatial frequencies is caused by the intrinsic spatial frequency content of the internal facial features (Keil, 2009). In other words, we use the spatial frequencies that allow us to perceive the internal facial features (eyebrows, eyes, nose, and mouth).

In Study 3 we filtered the set of faces used in Study 2 to pass either high- or low-spatial frequencies. By dividing the spatial frequency content in two, we sought to determine whether the changes in apparent feature size caused by makeup are due more to the emphasis of fine details or to coarse changes made to entire regions. We tested this by comparing the effect of makeup on perceived feature size in the low-pass and high-pass images.

Method

Models and image filtering. This study utilized the same set of 32 models and the same reference face as in Study 2. However, here we applied two different filters to each of the faces to remove certain spatial frequencies from the images. Each filter was applied with a cut-off of 10 cycles per face width (10 c/fw). Applying a low-pass filter to the faces resulted in a new image comprised of spatial frequencies from the original image below the cut off of 10 c/fw, whereas the high-pass filter retained only spatial frequencies above the 10 c/fw cut off. The low and high-passed filtered versions of the reference face are shown in Figure 4. We chose a cut off value of 10 c/fw as this value is well within the bounds of spatial frequencies (typically 8 – 16 c/fw) found to be important in face recognition (Costen, Parker, & Craw, 1994, 1996; Näsänen, 1999; Ojanpää & Näsänen, 2003; Ruiz-Soler & Beltran, 2006). Additionally, this cutoff value has been used to investigate other aspects of social perception from the face, such as age perception (Kloth, Damm, Schweinberger, & Wiese, 2015). In both cosmetics conditions we applied the low and high-pass Gaussian filter to each image using MATLAB, yielding four versions of each model—high- and low-pass versions with makeup and high- and low-pass versions without makeup. Each color channel (red, green, and blue) was filtered separately before being reconstituted into the full image. We also applied the filter to the reference face.

Figure 4. The image on the left is the reference face after being low-pass filtered, removing fine contours. The image on the right is the reference face after being high-pass filtered, removing low-level shape information. Filtering was applied to all models in both cosmetics conditions. See the online article for the color version of this figure.

Participants. Ninety-seven Gettysburg College students (80 females, age $M = 18.51$ years, $SD = 0.97$) participated in the study for partial credit for an introductory psychology class. Participants were informed they were taking part in a study investigating the basics of face perception, and were fully debriefed at the end of study. Participants took part over the duration of a fall term, with data being collected for the entirety of this period.

Procedure. The procedure in this experiment was identical to that of Study 2, but now consisted of two blocks that participants completed in a counterbalanced order. Participants compared the size of features (eyebrows, eyes, nose, and mouth) for low-pass filtered images to the low-pass filtered average face in one block, and completed the same task for high-pass filtered images compared with the high-pass filtered average in another block, for a total of 256 trials. Participants were assigned to either the without cosmetics ($n = 49$) or with cosmetics ($n = 48$) condition as in previous studies.

Results

We averaged perceived scores across participants to provide an average perceived size for each feature, in each cosmetics condition, for each filter level. This yielded 16 scores per face. We analyzed this data using a 2 (filter: high pass, low pass) × 2 (cosmetics: without, with) × 4 (feature: eyebrows, eyes, nose, mouth) repeated-measures ANOVA. The results are shown in Figure 5. There was a three-way interaction among filter, cosmetics, and feature, $F(3, 93) = 15.34$, $p < .001$, $\eta_p^2 = .33$. This indicates that the interaction between the presence or absence of makeup and the high- and low-pass filters was not the same for each of the features. We sought to explain this interaction, and given that the effect on each feature is of interest, we carried out a separate 2 (filter: high pass, low pass) × 2 (cosmetics: without, with) ANOVA for each feature to examine how spatial frequency and cosmetics might interact for the eyebrows, eyes, nose, and mouth.

Eyebrows. For the eyebrows, we observed only a main effect of cosmetics, $F(1, 31) = 42.03$, $p < .001$, $\eta_p^2 = .57$, indicating that features appeared larger with cosmetics ($M = -1.37$, 95% CI [−6.23, 3.47]) than without cosmetics ($M = -6.10$, 95% CI [−11.69, −0.51]). Importantly, there was neither a significant interaction between filter and cosmetics, $F(1, 31) = 0.40$, $p = .530$, $\eta_p^2 = .01$, nor a significant main effect of filter, $F(1, 31) = 2.45$, $p = .513$, $\eta_p^2 = .07$. These findings indicate the increase in the perceived size of the eyebrow was not specific to alterations in either spatial frequency domain.

Eyes. For the eyes, we observed a significant interaction between filter and cosmetics, $F(1, 31) = 25.15$, $p < .001$, $\eta_p^2 = .45$. There was a larger effect of cosmetics on perceived eye size in the low-pass condition (without $M = -4.51$, 95% CI [−7.71, −1.29], with $M = 4.46$, 95% CI [0.78, 8.14]), $t(31) = 10.77$, $p < .001$, $d = 1.90$) than in the high-pass condition (without $M = -1.25$, 95% CI [−5.02, 2.52], with $M = 3.48$, 95% CI [−0.41, 7.38]), $t(31) = 5.65$, $p < .001$, $d = 0.99$.

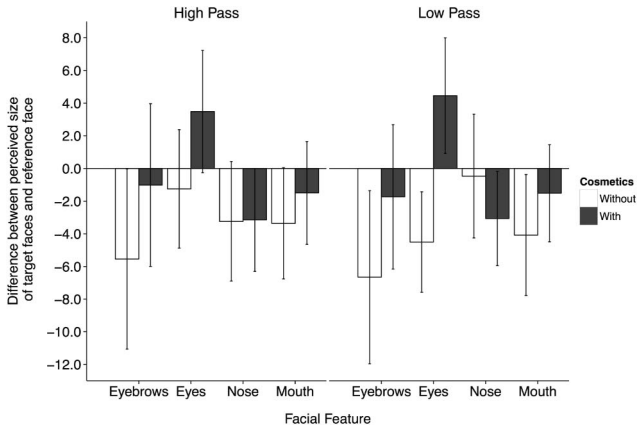

Figure 5. The difference between perceived size of the features in the target faces and in the reference face. Positive values indicate that the target feature was perceived to be larger on average than the reference feature. Error bars represent 95% confidence intervals. The pattern of results was broadly the same as in Study 2, with eyebrows and eyes looking larger in the makeup condition and noses looking smaller in the no makeup condition. However, the effect of makeup on apparent eye size was larger in the low-pass condition, and the effect of makeup on apparent nose size was nonexistent in the high-pass condition. Also different than in Study 2, there was an effect of makeup on apparent mouth size, with mouths looking larger in the makeup condition.

Nose. For the nose, we also observed a significant interaction between Filter and Cosmetics, $F(1, 31) = 14.15$, $p = .001$, $\eta_p^2 = .31$. In the high-pass condition cosmetics did not affect the perceived size of the nose (without $M = -3.24$, 95% CI [−7.05, 0.57], with $M = -3.15$, 95% CI [−6.43, 0.13]), $t(31) = 0.12$, $p = .904$, $d = 0.02$. However, in the low-pass condition cosmetics made the nose appear significantly smaller (without $M = -0.46$, 95% CI [−4.40, 3.47], with $M = -3.06$, 95% CI [−6.06, 3.47]), $t(31) = 3.18$, $p = .003$, $d = 0.56$.

Mouth. For the mouth, we observed only a main effect of Cosmetics for the mouth, $F(1, 31) = 6.09$, $p = .019$, $\eta_p^2 = .16$, with faces having slightly larger features with cosmetics ($M = -1.51$, 95% CI [−4.64, 1.63]) than without ($M = -3.72$, 95% CI [−7.38, −0.05]). There was no interaction between filter and cosmetics, $F(1, 31) = 1.17$, $p = .287$, $\eta_p^2 = .04$, nor a main effect of Filter, $F(1, 31) = 0.68$, $p = .415$, $\eta_p^2 = .02$. This indicated no effect of spatial frequency information on the perceived size of the mouth.

Discussion

In the third study, we observed that cosmetics affect the perceived size of facial features even when the range of spatial frequencies is restricted. Eyebrows appeared larger with cosmetics regardless of the spatial frequency content available, suggesting that the effect of cosmetics on apparent feature size is not conveyed exclusively by either low or high spatial frequencies. Eyes were also perceived as larger with cosmetics in both filter conditions, but the effect was greater with low spatial frequencies. The nose appeared smaller with cosmetics, but only when comparisons were restricted to low spatial frequency information. This is consistent with the idea that the effect is due to contouring, which involves the application of darker and lighter foundation that is smoothly blended so that there are no clear lines or edges between the darker and lighter regions.

Unexpectedly, there was also an effect of cosmetics on perceived mouth size in this experiment. The effect was not moderated by spatial frequency. Since we did not observe this effect in Studies 1 and 2 with unmanipulated images, it is possible that the effect in Study 3 was somehow an artifact of the spatial frequency filtering. However, we did initially predict an effect of cosmetics on perceived mouth size, as have several others (Bruce & Young, 1998; Morris, 2002; Zebrowitz, 1997), and so we note that the results from Study 3 do provide some evidence for such an effect. However, it is likely this effect is a small one, given both the effect size ($\eta_p^2 = .16$) and the fact it appeared in only one of three studies.

It is important to note that we examined only the effect of filtering spatial frequencies above and below a cutoff of 10 c/fw. This is a rough division of the spatial frequency range; it is possible that a more fine-grained analysis of the role of different spatial frequencies would reveal that particular frequencies are critical for the manipulation of feature size by cosmetics.

General Discussion

In three studies using a novel reference paradigm we evaluated the hypothesis that makeup makes some of the internal facial features appear larger. We predicted that the eyes and mouth would look larger with makeup. Indeed, the eyes were perceived as larger with makeup than without across all three studies, corroborating recent work by Morikawa et al. (2015). However, we found no evidence that mouths were perceived as larger in Studies 1 and 2, with unmanipulated images. However, the mouth was perceived as slightly larger with makeup in Study 3, in both the high-pass and low-pass filtered images (i.e., images that contained only high spatial frequency information or only low spatial frequency information). The eyebrows appeared larger with makeup in the two studies that measured its apparent size (Studies 2 and 3), also in both high-pass and low-pass filtered images. We predicted that nose size would not be affected by self-applied makeup, but would be affected by professionally applied makeup. The results supported this prediction, as the noses in Study 1 (with self-applied makeup) did not look different with makeup, whereas in Studies 2 and 3 (with professionally applied makeup) the noses were perceived as smaller with makeup. Collectively, the findings provide clear evidence that makeup changes the apparent size of the internal facial features, with different effects in different features.

These results support the idea that modification of the apparent size of the facial features is one of the ways that makeup enhances facial attractiveness. Facial feature size is related to two of the major factors of facial attractiveness—age (Berry & McArthur, 1985; Enlow, 1975; Zebrowitz, 1997) and sexual dimorphism(Burriss, Little, & Nelson, 2007; Enlow, 1975; Koehler, Simmons, Rhodes, & Peters, 2004). Larger eyes and lips are associated with younger faces and with female faces. Also, lip growth is influenced by estrogen, the female sex hormone (Johnston & Franklin, 1993). Nose size is also sexually dimorphic, with males possessing larger, wider noses than females, and nose width is correlated with perceived masculinity (Burriss et al., 2007; Koehler et al., 2004). Thus, the current findings add further support to the view that makeup works in part by modifying biologically based factors of beauty (Russell, 2010). The modification of these factors of beauty

is achieved through the manipulation of particular visual features, including facial contrast (Jones et al., 2015; Russell, 2009) and skin homogeneity (Fink et al., 2006; Matts et al., 2007). Facial feature size can be added this list of visual features that are modified by makeup and are related to known factors of facial attractiveness.

Evolutionarily inspired links between makeup use and different visual factors have been investigated. Lipstick or lip-gloss can make the lips appear wet, increasing their specular reflection. Humans are attracted to glossy objects, and this preference for gloss has been proposed to stem from a need for water (Meert, Pandelaere, & Patrick, 2014). Cheeks become redder during ovulation, though at a level that may be imperceptible (Burriss et al., 2015), and red cheeks are preferred by observers (Jones et al., 2016). Cosmetic products like blush seem designed to exaggerate this desirable coloration. There are also associations with the color red and sexual attractiveness (Elliot & Niesta, 2008; Niesta Kayser, Elliot, & Feltman, 2010), which may indicate cosmetics are used or interpreted as a signal of sexual intent. There is also evidence that women wear more cosmetics during ovulation (Guéguen, 2012), lending support to the notion that cosmetics can signal sexual status, and to the notion that an evolutionary aesthetics framework can shed light on makeup use.

An important remaining question is how makeup changes the apparent size of the features. Morikawa et al. (2015) showed evidence that eyeshadow increases the assimilation between the eyes and eyebrows, meaning that eyeshadow increases the perception of the eyes and brows as a single unit or feature. Insofar as the eyes and eyebrows were the only features whose apparent size was reliably increased by makeup in our three experiments, our results are consistent with this account. However, our makeup stimuli also included mascara, eyeliner, and eyebrow pencil, so the results are not strictly comparable. We suspect that other factors in addition to assimilation are also at play. For features that are made to appear larger—the eyebrows and eyes, possibly the mouth—there may be some overlap between apparent size and contrast. Specifically, all of these features are darkened by makeup, resulting in increased contrast between these features and the surrounding skin (Etcoff et al., 2011; Jones et al., 2015; Russell, 2009). It is possible that this increase in contrast has an effect on apparent size. Another possibility is that the increase in skin homogeneity caused by foundation reduces the 'noise' around the facial features, which somehow enhances their apparent size. The apparent shrinking of the nose is presumably due to the chiaroscuro effects of contouring, a popular but specialized technique of makeup application (Pearl, 2004). This involves a very subtle, blended change in apparent darkness along the sides of the nose, consistent with the finding that noses appeared smaller in the low-pass filter condition but not the high-pass filter condition. Regarding the eyebrows, it is important to note that it is common to remove some of the brow hairs, particularly along the bottom margin. Presumably many of the faces in the sets used here have eyebrows that had already been resized in this way, but this would have affected both the makeup and no makeup images.

Importantly, none of the people applying the makeup were given instructions about changing the apparent feature size. The women who applied their own makeup in Study 1 were instructed simply to apply their cosmetics as if they were going on a 'night out.' The makeup artist who applied the makeup to the faces in Studies 2 and 3 was instructed to apply makeup to make the women more beautiful. In both cases, those applying the makeup were blind to the hypothesis of this study. Popular accounts and instructions for applying makeup commonly describe ways to modify the size of the facial features (Aucoin, 1997, 2000). We suspect that the effect of makeup on perceived facial feature size could be greater if the person applying makeup had the explicit goal to make the features appear larger. Also, we did not control for individual differences in facial feature sizes between models. Future work might take up the question of whether faces with naturally larger or smaller facial features experience a larger effect of makeup on perceived feature size.

In conclusion, we have shown here that makeup changes the apparent size of the features. In two different, carefully controlled sets of photographs, the same women were photographed with makeup and without makeup. The eyebrows and eyes appeared larger with makeup than without makeup. Interestingly, the noses appeared smaller with makeup, but only when a professional makeup artist applied the makeup. Finally, the mouth did not appear different in size with or without makeup. However, in high- or low-pass filtered images (including only fine details or only coarse features), the mouth did appear slightly larger. These findings are consistent with the idea that changing the apparent sizes of the features is one of the ways that makeup is able to enhance facial attractiveness. As feature size is related to age and sex, these findings provide further support to the notion that makeup functions in part by modifying biologically based factors of beauty (Russell, 2010).

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