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CHANGES IN ATTRACTIVENESS OVER THE MENSTRUAL CYCLE DUE IN PART TO CHANGES IN ACNE AND SKIN OILINESS

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ABSTRACT

Ovulation in many female mammals is preceded by estrus, physical changes that advertise to potential mates their high fertility status and act to attract male mating efforts. In humans, estrus was previously assumed to have been lost because natural selection favored concealed ovulation, but recent evidence shows that there are subtle changes in females that may help both males and females to detect ovulatory status of other women. Varying levels of estradiol and progesterone across the cycle act as a strong marker for ovulatory status that we cannot observe directly, but clearly have an effect. Past research has showed that women are rated as more facially attractive at ovulation when they are most fertile, suggesting some change that people are unconsciously able to pick up. Using a subsample of photos and hormone measures from a previous study, we investigated possible physical changes occurring that may be responsible for differential ratings of attractiveness across the cycle. The current study had 188 participants come into the lab to rate 83 pairs of photos in a forced-choice survey in which each set contained a photo of the same woman taken at low fertility and one taken at high fertility. Participants were asked to choose between the two session photos for these characteristics: acne, brightness of complexion, skin oiliness, friendliness, and attractiveness. Acne was found to be significantly correlated with change in estradiol, and oiliness significantly correlated with change in progesterone. Attractiveness correlated positively with friendliness and brightness, but correlated negatively with oiliness and acne.

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Chapter 1

Introduction

In many female mammals, ovulation is immediately preceded by estrus, a variety of changes in behavior, odor and appearance, for instance the swelling of the genitals in chimpanzees (Gangestad and Thornhill, 2008). These visible cues act to alert possible mates to the higher probability of producing offspring and work to increase their mating efforts. Human females do not experience the same kind of obvious changes that advertise fertility, suggesting that evolution favored suppressed ovulation in our species (Benshoof and Thornhill, 1979). The inability to know when a female is ovulating can help women retain male investment due to an attempt by males to insure paternity.

Concealed ovulation creates an adaptive problem for males who don’t have the obvious sign of a swollen rump to be sure when a female is fertile. However, if males were able to detect subtle cues to fertility, even subconsciously, they could direct their mating efforts more efficiently and have higher reproductive success. Studies have shown that subtle cues of ovulation can be picked up by men successfully, albeit subconsciously (Haselton and Gildersleeve, 2011; Haselton and Gangestad, 2006). In a study on the effects of menstrual cycle on the tips of strippers, estrous women made 40% more in tips per hour than women in the luteal phase of their cycle and on average double than when menstruating (Miller et al., 2007).

An effect such as this demonstrates that ovulation status is not quite as concealed in humans as we once assumed. Researchers have found that ratings of female facial attractiveness change over the menstrual cycle, with men favoring women during the late follicular phase when fertility is high (Roberts et al., 2004; Puts et al., 2013; Law Smith et al., 2006). Men that are completely unaware of the ovulatory status of the women they rate prefer women at or near ovulation to those in the luteal phase of their cycle.

Women also stand to gain from detecting the ovulatory status of others. Because women desire more extra-pair sex near ovulation, picking up on the signs of a fertile woman nearby can make them better able to respond by increasing mate-guarding behaviors (Haselton and Gangestad, 2006). Consistent with this theory, evidence demonstrates that women also rated the faces of other women as more attractive when in the late follicular phase (Roberts et al., 2004; Puts et al., 2013; Law Smith et al., 2006).

Research shows that there are a few key hormones that change dramatically across the menstrual cycle and seem to have an impact on attractiveness. Estradiol and progesterone are the key hormones that have been tracked most across the menstrual cycle. Estradiol climbs in the follicular phase, and then drops off drastically at ovulation. Progesterone levels stay low in the follicular phase, peak in the middle of the luteal phase, and then drop down again. The interaction of these hormones can be used to accurately estimate the day of ovulation (Baird et al., 1995).

While studies show female faces are found to be more attractive at ovulation, previous research has not yet measured the exact physical changes that are occurring in the face as a result of hormonal changes. There are several plausible candidates, however, including slight facial expressions (e.g., those that might be perceived as indicating friendliness), brightness of complexion, oiliness of the skin, and acne.

Common wisdom tells us that a smile can instantly make someone prettier, and studies on the effect of smiling prove this to be true. Researchers had men and women rate photos both of women smiling and maintaining a neutral expression and found that the smiling photos were rated as considerably more attractive (Reis et al., 1990). If women are more friendly and receptive to male advances during the fertile time in the cycle, there is likely an effect on rated facial friendliness. Although women in the current study were instructed in both lab sessions to assume a neutral expression, there may still be small but perceptible changes in facial expression that would affect judgments of friendliness between high fertility and low fertility days.

Brightness of the skin may also change over the cycle, but other components of the face may affect perceptions of brightness as well. In a study examining the effects of smiling and frowning on perceived brightness, researchers found that smiling faces were rated as brighter than frowning faces with the same luminance (Song et al., 2011). Because smiling increases attractiveness as well as apparent brightness, there may be a correlation between perceived brightness and attractiveness.

Skin oiliness is related to increased activity of the sebaceous glands (Steventon, 2011). Sebum production is typically kept under control by high levels of estrogen during the follicular phase of the cycle. During the mid-luteal phase, low levels of estrogen and high levels of progesterone correspond to increased production of the sebaceous glands (Arora et al., 2011). Because sebum produces the effect of oily skin, skin oiliness should increase after the ovulatory drop in gland-controlling estrogen and mid-luteal rise in progesterone (Steventon, 2011).

Acne has been studied extensively in connection to the menstrual cycle and hormone levels. In a sample of 400 women, data collected from self-report found that 44% experienced flare-ups prior to menstruating (Stoll et al., 2001). A more recent study (Lucky 2004) took a quantitative approach to document acne flares across two menstrual cycles. Counts of inflammatory lesions increased 25.3% on average from the follicular to luteal phases and 63% of the women in the sample had increases in lesions during this time. The timing of the decrease in attractiveness during the luteal phase (Puts et al., 2013) corresponds to flare-ups in acne. We intend to explore if acne is directly related to the perception of attractiveness, or if changes in attractiveness and acne are simply occurring simultaneously due to hormone changes.

Hypothesis

In the present research, we explored relationships between physical changes in facial appearance and changes in levels of progesterone and estradiol. We expected to find that photos rated as more attractive would be rated as more friendly and bright, but with less acne and oiliness of the skin. Changes in estradiol and progesterone levels were expected to predict differences in the perception of acne, attractiveness, brightness, oiliness, and friendliness. We also endeavored to replicate findings that women are rated as more attractive close to ovulation, this time after removing ornamentation cues such as hair.

Chapter 2

Methods

A total of 188 participants (64 male) took part in this research in exchange for extra credit in an undergraduate anthropology course. Participants came to the lab during scheduled sessions. After giving informed consent and completing an unrelated sports-interest study, participants completed a short demographic survey. Participants then completed the five sections of the present study (see below). Each section first presented a white screen with instructions (e.g. “Please choose the face that has more ACNE from the following pairs.”) followed by 16 or 17 frames, each with the question present (e.g. “Which has more ACNE?”) and a pair of pictures below. Each pair represented the same female in the high-fertility and low-fertility phases. The participant responded by pressing one of two keyboard keys, q for the left and p for the right. Upon completion, participants were thanked for their time.

Stimuli and hormone collection

Puts et al. (2013) previously conducted a study in which photos and hormone measures were gathered from 202 women at a large Midwest U.S. university. The subjects were normally cycling (mean age 19.6, ±1.6 years). Women scheduled two laboratory sessions according to their self-reported menstrual cycle length and the last day of their period. One session occurred within a day of peak expected production of estradiol during the follicular phase, and the other within two days of expected peak production of progesterone during the luteal phase. Session order was counterbalanced across the women, and sessions were scheduled between 1300 h and 1600 h to minimize effects of circadian fluctuations on data. Participants were provided wet wipes and instructed to remove any makeup, jewelry or eyeglasses and to assume a neutral expression. Facial photographs were taken with a tripod-mounted

Canon PowerShot S10 digital camera at a distance of approximately 1 m, a height adjusted to the participant, and using constant lighting across participants. All face images were cropped beneath the chin, normalized on interpupillary distance, and rotated so that both pupils lay on the same horizontal plane.

Participants collected approximately 9 ml of saliva in sodium azide-treated polystyrene test tubes during both sessions. Contamination of saliva samples was minimized by having participants not eat, drink (except plain water), smoke, chew gum, or brush their teeth for 1 h before each session. Participants rinsed their mouths with water before chewing a piece of sugar-free Trident gum (inert in salivary hormone assays) to stimulate saliva flow. The tube was capped and left upright at room temperature for 18–24 h to allow mucins to settle. Tubes were then frozen at − 20 °C until analysis by the Neuroendocrinology Assay Laboratory at the University of Western Ontario, Canada.

Per previous research (e.g., Hampson et al., 2005 and Oinonen and Mazmanian, 2007), progesterone was assayed using ^{125}I Coat-A-Count assay kits (Diagnostic Products Corporation, Los Angeles, CA) modified for use with saliva. Similar to previous research (e.g., Finstad et al., 2009), estradiol was assayed using ^{125}I Ultra-Sensitive E_2 RIA DSL-4800 kit (Diagnostic Systems Laboratories, Webster, TX) modified for use with saliva. Each sample was assayed twice, and average hormone levels for each sample were used in our analyses. Assay sensitivities were 0.65 pg/ml and 5 pg/ml, and intra-assay coefficients of variation were 5.1% and 10.7%, for estradiol and progesterone, respectively.

The current study used a subsample of these data. Of the original 202 participants, 172 had progesterone and estradiol measures for both lab sessions. After those without all of the necessary measures were eliminated, the photos were reviewed individually. From the images, it was clear that many of the women had not fully removed their makeup as instructed. Makeup use has been shown to significantly increase ratings of attractiveness and facial healthiness (Cash et al., 1989; Smith et al., 2006). Because the current study was to investigate naturally occurring changes and the application of makeup may contribute to the reason women are found to be more attractive at ovulation, all photo sets with obvious makeup were eliminated. The final sample size then included 83 pairs of photos.

The literature shows that women make changes to their appearance depending on fertility status. In a study on ornamentation across the cycle, Haselton et al. (2006) presented raters with a pair of photos of the same woman, one during high fertility and one during low. The women's faces were masked so that facial attractiveness and expression would not confound results and only ornamentation choices could be judged. Raters were instructed to choose the photo in which the person was trying to look more attractive, using a forced-choice approach. Data showed that both men and women rated the high fertility photo as trying to look more attractive. With the results of this study in mind, all images were masked, leaving only the face itself so that ornamentation such as earrings or hairstyle would not confound data.

Creating the Survey

Each rater participant evaluated the 83 pairs of faces on one characteristic each. To separate the photo sets evenly, five versions of the survey were originally created using SuperLab software. Within each survey version, five sections were created, each devoted to obtaining judgments on one of the five characteristics. To distribute the photos among the characteristic sections, the first 16 or 17 image pairs were assigned to the first version for one characteristic (e.g. Acne), the next 16 or 17 image pairs were assigned to that version for the second characteristic (e.g. Brightness) and so on for all five characteristics, so that each rater saw all 83 image pairs, and made a judgment of each on one of the five characteristics. In this way, each participant judged each photo pair on only one characteristic, and the session choices within participant judges were not biased by presentation of the same photo pair for multiple characteristics.

To eliminate the influence of any laterality biases, the five versions of the survey were counterbalanced with an otherwise identical version in which the laterality of stimuli in each pair was reversed. The presentation of the order of the characteristics rated was randomized within each version so that different participants taking the same survey version would be asked about each of the characteristics in a random order. Within the characteristic sections, the presentation order of the image pairs was also randomized.

Data treatment and analysis

The unit of analysis for the data is the image as opposed to the rater, and dependent variables were the proportion of time that raters chose the first session for each of the characteristics. Proportions were calculated for judgments made by male and female observers combined as well as separately. Changes in progesterone and estradiol were obtained by subtracting the second lab session's measurement of each hormone from the first lab session's measurement. Hormone concentrations from each stimulus collection session were not normally distributed, so first they were natural log-transformed to correct skew.

We explored the influence of changes in hormone levels on changes in facial appearance first through zero-order correlations, and then through a series of multiple linear regressions. In each regression model, we used changes in hormone levels from Session 1 to Session 2 to predict the proportion of Session 1 images that were chosen over the paired Session 2 images for each characteristic. For example, if between-session changes in estradiol caused changes in facial attractiveness, then an increase in estradiol from Session 1 to Session 2 would be associated with the Session 1 image being infrequently chosen as the more attractive. For each of the five characteristics, we ran two separate regression models. The first examined only the main effects of changes in estradiol and progesterone, and the second also took into account the interaction between estradiol and progesterone changes. In the first, changes in estradiol and progesterone, and the proportion of raters that were female were entered in as predictor variables. The second test included these predictor variables, and added the interaction between estradiol and progesterone (natural log-transformed to correct skew).

Chapter 3

Results

Table 1. Descriptive statistics

	Mean	Standard Deviation
Proportion of judges who were female	.66	.014
Age of female judges (years)	19.41	1.15
Age of male judges (years)	19.47	1.37
Session 1 Estrogen (pg/ml)	2.90	6.897
Session 2 Estrogen (pg/ml)	2.70	7.629
Session 1 Progesterone (pg/ml)	91.52	79.198
Session 2 Progesterone (pg/ml)	71.23	49.921

Proportions of Session 1 images chosen by men and women were strongly correlated for all five characteristics ($.77 \leq r_{83} \leq .90$, all $p < .0001$; Table 2), so further analysis was performed for male and female judgments together.

Table 2. Zero-order correlations between all judgments by sex

		2	3	4	5	6	7	8	9	10
1	Male judgments of acne	-.52***	-.08	-.38**	.20^{+}	.89***	-.5***	-.34**	-.32**	.21^{+}
2	Male judgments of attractiveness		.25*	.63***	-.135	-.56***	.80***	.50***	.63***	-.14
3	Male judgments of brightness			.26*	.26*	-.1	.23*	.77***	.17	.26*
4	Male judgments of friendliness				-.07	-.44***	.70***	.40***	.77***	-.12
5	Male judgments of					.17	-.13	.12	-.08	.90***

	oiliness									
6	Female judgments of acne						-.52***	-.34***	-.37**	.19⁺
7	Female judgments of attractiveness							.45***	.79***	-.17
8	Female judgments of brightness								.35**	.14
9	Female judgments of friendliness									-.12
10	Female judgments of oiliness									---

+ p<.10, * p<.05, ** p<.01, ***p<.001

We computed Pearson product-moment correlation coefficients to examine relationships between the different facial characteristics with all data from women and men computed together (See Table 3). The single strongest correlation was found between perceptions of friendliness and attractiveness, r_{83} = .790, p<.001. There was a negative correlation between friendliness and acne, r_{83} = -.415, p<.001, and a positive correlation between friendliness and brightness, r_{83} = .339, p =.002. A positive correlation between brightness and attractiveness was found, r_{83} = .424, p<.001. Brightness and acne were weakly negatively correlated, r_{83} = -.280, p =.01. Only two characteristics correlated significantly with changes in hormone levels. Change in estradiol weakly correlated with judgments of acne, r_{83} = .251, p =.022, and change in progesterone weakly correlated with oiliness, r_{83} = .237, p =.031. The change in estradiol and change in progesterone were not strongly correlated to each other, r_{83} = .204, p =.064.

Judgments of acne correlated weakly with the change in estradiol between sessions (r_{83} = .25, p = .022) but were unrelated to changes in progesterone (r_{83} = .005, p = .964). The amount of variation in judgments of acne explained by changes in progesterone and estradiol together did not achieve statistical significance (multiple regression model: $F_{3, 79}$ = 2.095, p =.107, adj. R^2 =.039, see Table 4). However, changes in estradiol alone significantly predicted the variation in proportion of time Session 1 was chosen as having more acne in this model (*β* =.265, *t* =2.396, *p* =.019). After adding the interaction of changes in estradiol and progesterone as a predictor variable, the model was a worse fit ($F_{4,\ 78}$ =1.553, *p* =.195, adj. R^2 =.026). Change in estradiol still significantly predicted variation in judgments of acne (*β* =.271, *t* = 2.030, *p* =.046).

Table 3. Zero-order correlations between variables

		2	3	4	5	6	7
1	Change in Estradiol	0.20⁺	.25*	-.14	-.06	-.14	0.17
2	Change in Progesterone		.01	0.08	-0.03	0.07	.24*
3	Acne			-.57***	-.28*	-.42**	0.18
4	Attractiveness				.42***	.79***	-0.14
5	Brightness					.34**	0.15
6	Friendliness						0.08
7	Oiliness						---

+ *p*<.10, * *p*<.05, ** *p*<.01, *** *p*<.001
Change in Progesterone and Change in Estradiol natural log-transformed to correct skew

Table 4. Multiple regression predicting acne

Model	**Variable**	***β***	***t***	***p***
1	Change in Estradiol	.265	2.396	.019
	Change in Progesterone	-.042	-.382	.704
	Prop. Raters Female	.093	.86	.392
2	Change in Estradiol	.271	2.030	.046
	Change in Progesterone	-.041	-.362	.718
	Change in Estradiol x Change in Progesterone	-.010	-.072	.942
	Prop. Raters Female	.093	.840	.403

Zero-order correlations showed that judgments of attractiveness were not connected to changes in estradiol (r_{83} = -*.14*, *p* = .208) or progesterone (r_{83} =.08, *p* = .497). Regression models showed that judgments of attractiveness were unrelated to changes in the measured hormones, ($F_{3, 79}$ = .862, *p* =.464, adj. R^2 = -.005, see Table 5). Attractiveness was not predicted by changes in either progesterone (β =.107, *t* = .945, *p* =.347) or estradiol, (β = -.160, *t* = -1.415, *p* =.161). Adding the interaction of changes in estradiol and progesterone as predictors revealed an even worse fit ($F_{4, 78}$ = .661, *p* =.621, adj. R^2 = -.017).

Table 5. Multiple regression predicting attractiveness

Model	**Variable**	***β***	***t***	***p***
3	Change in Estradiol	-.160	-1.415	.161
	Change in Progesterone	.107	.945	.347
	Prop. Raters Female	-.031	-.275	.784
4	Change in Estradiol	-.182	-1.339	.185
	Change in Progesterone	.101	.872	.386
	Change in Estradiol x Change in Progesterone	.041	.297	.767
	Prop. Raters Female	-.033	-.299	.766

The proportion of time that Session 1 photo was picked to be brighter was not correlated with either changes in estradiol (r_{83} = -.06, *p* =.577) or progesterone, (r_{83} = -.03, *p* = .76). In the first regression model predicting brightness, judgments of this characteristic were unrelated to measured changes of progesterone and estradiol ($F_{3, 79}$ = .443, *p* =.723, adj. R^2 = -.021; see Table 6). The proportion of time that the Session 1 photo was chosen to have a brighter complexion was not predicted by either change in estradiol (β = -.047, *t* = -.408, *p* =.685), or progesterone (β = -.006, *t* = -.054, *p* =.957). Adding the interaction of estradiol and progesterone again showed no effect ($F_{4, 78}$ = .338, *p* =.852, adj. R^2 = -.033; interaction of change in estradiol and progesterone (β = -*.028, t* = -.197, *p* =.844)).

Table 6. Multiple regression predicting brightness

Model	Variable	*β*	*t*	*p*
5	Change in Estradiol	-.047	-.408	.685
	Change in Progesterone	-.006	-.054	.957
	Prop. Raters Female	-.112	-.990	.325
6	Change in Estradiol	-.032	-.232	.817
	Change in Progesterone	-.002	-.021	.983
	Prop. Raters Female	-.111	-.964	.338
	Change in Estradiol x Change in Progesterone	-.028	-.197	.844

Participants' judgments of friendliness were not correlated with change in estradiol (r_{83} = -.14, *p* = .203) or progesterone (r_{83} = .07, *p* = .511). In the regression model, judgments of friendliness were unrelated to changes in estradiol and progesterone ($F_{3, 79}$=.846, *p* =.473, adj. R^2= -.006; see Table 7). Estradiol changes were unrelated to perceptions of friendliness (β = -.16, *t* = -1.405, *p* = .164), as were changes in progesterone, (β = .10, *t* =.852, *p* =.397). The interaction of progesterone and estradiol was likewise unlinked to perceptions of friendliness ($F_{4, 78 =}$ .687, *p* =.603, adj. R^2= -.016).

Table 7. Multiple regression predicting friendliness

Model	Variable	*β*	*t*	*p*
7	Change in Estradiol	-.160	-1.405	.164
	Change in Progesterone	.100	.852	.397
	Prop. Raters Female	-.021	-.180	.857
8	Change in Estradiol	-.198	-1.425	.158
	Change in Progesterone	.094	.785	.435
	Prop. Raters Female	-.010	-.087	.931
	Change in Estradiol x Change in Progesterone	.068	.483	.631

Zero-order correlations revealed a statistically significant relation between changes in progesterone and judgments of skin oiliness (r_{83} = .237, p = .031). Changes in estradiol were not correlated with judgments of oiliness, (r_{83} = .174, p =.116). The amount of variation in oiliness predicted by the change in progesterone bordered on statistically significant (β = .196, t = 1.741, p =.086). The complete model with change in estradiol and proportion of female raters was marginally statistically significant ($F_{3, 79}$ = 2.187, p =.096, adj. R^2= .042; see Table 8), and the model with the interaction of estradiol and progesterone added was not statistically significant ($F_{4, 78}$ = 1.684, p =.162, adj. R^2 = .032). However, the model including the interaction between estradiol and progesterone showed a marginally significant effect of progesterone changes, (β = .205, t = 1.789, p =.078).

Table 8. Multiple regression predicting oiliness

Model	**Variable**	***β***	***t***	***p***
9	Change in Estradiol	.135	1.223	.225
	Change in Progesterone	.196	1.741	.086
	Prop. Raters Female	.067	.604	.548
10	Change in Estradiol	.171	1.284	.203
	Change in Progesterone	.205	1.789	.078
	Prop. Raters Female	.068	.615	.540
	Change in Estradiol x Change in Progesterone	-.066	-.488	.627

Chapter 4

Discussion

The present study examined cyclic variations occurring at the physical level reflected by hormonal changes. Acne was not found to be linked to progesterone, but it was predicted by changes in estradiol. Previous studies have documented this link, showing that estrogen is an important factor in controlling sebaceous glands, helping to decrease acne (Arora et. al, 2011; Steventon, 2011). Estrogen's role in mediating acne is recognized clinically, as we can see in the administration of estrogen-based contraceptives in some cases of severe acne. Changes in progesterone predicted changes in perceptions of oiliness as hypothesized. Progesterone's effect on the production of sebaceous glands is reflected in oilier skin during the mid-luteal phase. Because both progesterone and estradiol affect sebaceous gland production, the lack of a relationship between oiliness and acne was unexpected. In future studies, it would be interesting to look at very specific timing and severity of acne and skin oiliness across the cycle to find their relation.

Unexpectedly, the data from this subsample did not show a significant effect of the cycle on attractiveness as was found in the full sample (Puts et al., 2013). There could be several reasons for this. After excluding image pairs with makeup, the subsample size was much smaller than in the original study. In this survey, the faces were then cropped of hair and ears as they had not been previously. It is possible that the changes in attractiveness that were formerly found are related more to ornamentation choices such as hairstyle or makeup than to physical changes of the skin.

Numerous studies have demonstrated the link between facial symmetry and attractiveness ratings (Fink et al., 2006; Perrett et al., 1999). In a study in which women rated images of men, significantly positive correlations were found between symmetry, facial health and attractiveness (Jones et al., 2004). These features are likely markers of genetic quality, with higher levels reflecting better genes. Because women have more cyclical fluctuations in hormones than men, ratings of facial health and attractiveness are more transient. Research suggests that symmetry in women varies cyclically with the menstrual cycle as well, and specific features noted to have fluctuating symmetry included the ears (Manning et al., 1996). It is possible that the absence of the ears from this study stripped judges of an important clue to fertility and contributed to the lack of evidence for ovulatory status. Without support for the role of hormones in changing attractiveness, it was not surprising that changes in progesterone and estradiol were also unrelated to judgments of brightness and friendliness in these data.

Though the effect may not be as large as expected, the data suggest that there are physical changes occurring during the cycle that are reflected in the perception of increased attractiveness close to ovulation. Additionally, many of the relationships were in the expected direction. Attractiveness was positively correlated with brightness, friendliness, and was negatively correlated with acne and oiliness, all as predicted. Women who have brighter skin and warmer expressions are more favorable, while more oily skin and acne is obviously detrimental. Whether the perception of friendliness affects judgment of brightness as Song et al (2011) found, or whether more attractive women were judged as more friendly and bright cannot be determined from these data.

Similar to the concept of brightness is facial coloring. Research has shown that images with more even coloring of the skin are rated as more healthy, a correlate of attractiveness (Fink and Matts, 2008). We did not ask judges to assess coloring due to concerns of lack of objectivity and reliability, but it would be interesting to explore relationships between coloring and perception of brightness. Another noteworthy relationship is that the identification of less severe acne correlated positively with friendliness and friendliness correlated with higher levels of attractiveness. Whether acne and the perception of friendliness are related, or there is simply a halo effect whereby the attractiveness of a given woman (acne as a factor) influences judgment of their friendliness, should be investigated further.

Limitations and further areas for study

The current study did not yield all of the expected results; however, there were limitations that could be addressed in future studies. Hormone measures and photos were taken only for one menstrual cycle each; tracking hormone levels and taking photos over several cycles should yield more accurate results. The menstrual cycle also consists of a very complicated interaction of hormones, of which we only investigated two. Testosterone is a third hormone that has a very large impact on skin changes across the cycle. Studies suggest that the ratio between estrogen and androgens are an important factor in sebaceous gland production (Arora et al., 2011; Steventon, 2011). High levels of plasma testosterone have been found linked to severe acne cases (Steinberger et al., 1981). Androgens have been studied in relation to acne for decades, but their effect on other changes of the skin should also be examined.

This study investigated relationships between features using judges, but there are other ways to research this. To obtain objective measures, images could be analyzed by computer software for features such as symmetry, coloring (uniformity and tone), face shape, and face texture. Further studies should focus on teasing apart the effect of ornamentation and other personal choices from natural physical changes. Additionally, the sample size of eighty-three is on the smaller side and should be expanded so that the data are more representative of the general population.

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ACADEMIC VITA

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EDUCATION

Pennsylvania State University — **Class of 2014**
Schreyer Honors College — **University Park, PA**

- Bachelor of Arts in Psychology
- Honors in Anthropology

Philips-Universität Marburg — **Spring 2013**
International Undergraduate Study Program — **Marburg, Germany**

- Lived and attended school to be immersed in German language and culture
- Completed German culture, politics, and history course

RESEARCH EXPERIENCE

Puts Lab — **Fall 2013-Present**
Thesis Research

- Conducted review of current literature to form a hypothesis
- Created survey to gather responses from undergraduate participants
- Oversaw administration of study to over 180 students
- Analyzed data to assess hypothesis

Dr. Kenneth Levy's Lab for Personality, Psychopathology, and Psychotherapy Research — **Fall 2011 -Spring 2011**
Research Assistant

- Transcribed Adult Attachment Interviews
- Coded clinical charts from patient files in a study to be published
- Consented participants for interview participation
- Assisted graduate students running EEG participants

GRANTS, AWARDS, AND SKILLS

Schreyer Honors College Scholarship- awarded $3500 for each of four years to enrich studies
Schreyer Ambassador Travel Grant- received $650 towards airfare to Germany
Liberal Arts Enrichment Award- obtained $2000 to help with expenses associated with studying abroad
Dean's List- eight of eight semesters
Intermediate knowledge of German