The Effect of Lighting and Photograph Exposure on Perceived Attractiveness

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Purpose: To assess the effect of various lighting conditions and photograph exposures on perceived attractiveness.

Methods: In the first experiment, 5 variably exposed photographs were taken of 10 subjects using a consistent lighting condition (45° superior box light). In the second experiment, 10 subjects were photographed under variable lighting conditions with consistent exposure: 1) 90° overhead box light, 2) ring light, 3) 45° superior box light, 4) built-in camera flash, 5) 2 straight on box lights, each 45° from midline, and 6) natural light. Participants were instructed to maintain a neutral expression, were placed in front of a standardized blue-gray background, and were photographed during a single session. Photographs were imported into an online survey platform (Qualtrics 2020) and displayed in random order. Volunteer survey respondents were instructed to rate the subject's attractiveness on a scale of 0 to 10. Between the two experiments, a total of 22,000 scored photographs were included in the analysis. Mixed ANOVA and pairwise comparisons with Bonferroni correction were used to compare between- and within-subject ratings.

Results: Lighting condition had a significant impact on perceived attractiveness ($p < 0.001$), with the 90° overhead box light achieving lower scores and the 45° superior box light yielding greater scores of attractiveness relative to the other conditions. Photograph exposure did not have a significant impact on subjective attractiveness ($p = 1.000$).

Conclusions: Our findings suggest that perceived attractiveness is enhanced when a 45° superior box light is used for illumination, and attractiveness is reduced when 90° overhead exposure is utilized. Exposure did not play a prominent role in perceived attractiveness.

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Clinical photography plays an important role in patient education, medical documentation, and assessment of outcomes following aesthetic interventions. However, while the importance of standardization is not a new concept,[1–3] inconsistent color, brightness, and background are frequently noted in pre- and postoperative photographs published in the plastic surgery literature.[4]

In aesthetic medicine, objective outcome measures are often challenging to define. As a result, evaluation of pre- and postoperative photographs plays a central role in assessing success, further emphasizing the importance of accurate image acquisition. While beauty can be altered by many interventions, ranging from application of cosmetics[5] to panfacial aesthetic treatments,[6] different methods of photography can also change an individual's perceived attractiveness.[7]

Several components must be considered to ensure optimal standardization of clinical photographs. For instance, photographs obtained inappropriately close to the subject can distort facial features and[8] changes in the symmetry of lighting can alter the perceived three dimensionality of facial features, and alteration of lighting angles can disproportionately emphasize certain characteristics.[9] As a result, even in the absence of an aesthetic intervention, a change in photograph parameters alone may lead to a perceived cosmetic improvement.[10] The purpose of this study was to evaluate the impact of photograph exposure and lighting condition on a given subject's perceived attractiveness.

METHODS

This study complied with the University of California Los Angeles Institutional Review Board policies and principles, was conducted in accordance with the Declaration of Helsinki, and was Health Insurance Portability and Accountability Act compliant. Participant consent was obtained for use of identifiable photographs.

In the first experiment, 5 variably exposed photographs were taken of 10 subjects using a 45° superior box light. The same shutter speed (1/60) and ISO (200) were used, and the aperture was varied in 1/3 stop increments (f 8, 9, 11, 13, and 16), centered on the optimal exposure as determined by incident light metering (Sekonic L-308X-U Flashmate Light Meter, Seattle, WA, U.S.A.).

In the second experiment, 10 subjects were photographed under 6 lighting conditions: 90° overhead box light (Fig. 1A), ring light (Fig. 1B), 45° superior box light (Fig. 1C), built-in camera flash (Fig. 1D), 2 eye-level box lights, each 45° from midline (Fig. 1E), and natural light (Fig. 1F). A fixed shutter speed (1/60) and ISO (200) were used for all conditions and a light meter (Sekonic L-308X-U Flashmate Light Meter) held at subject eye level was used to determine the required aperture (f) to achieve a consistent exposure for all lighting conditions.

To minimize the introduction of confounding variables, participants in both experiments were instructed to maintain a neutral expression, were placed in front of a standardized blue-gray background, and were

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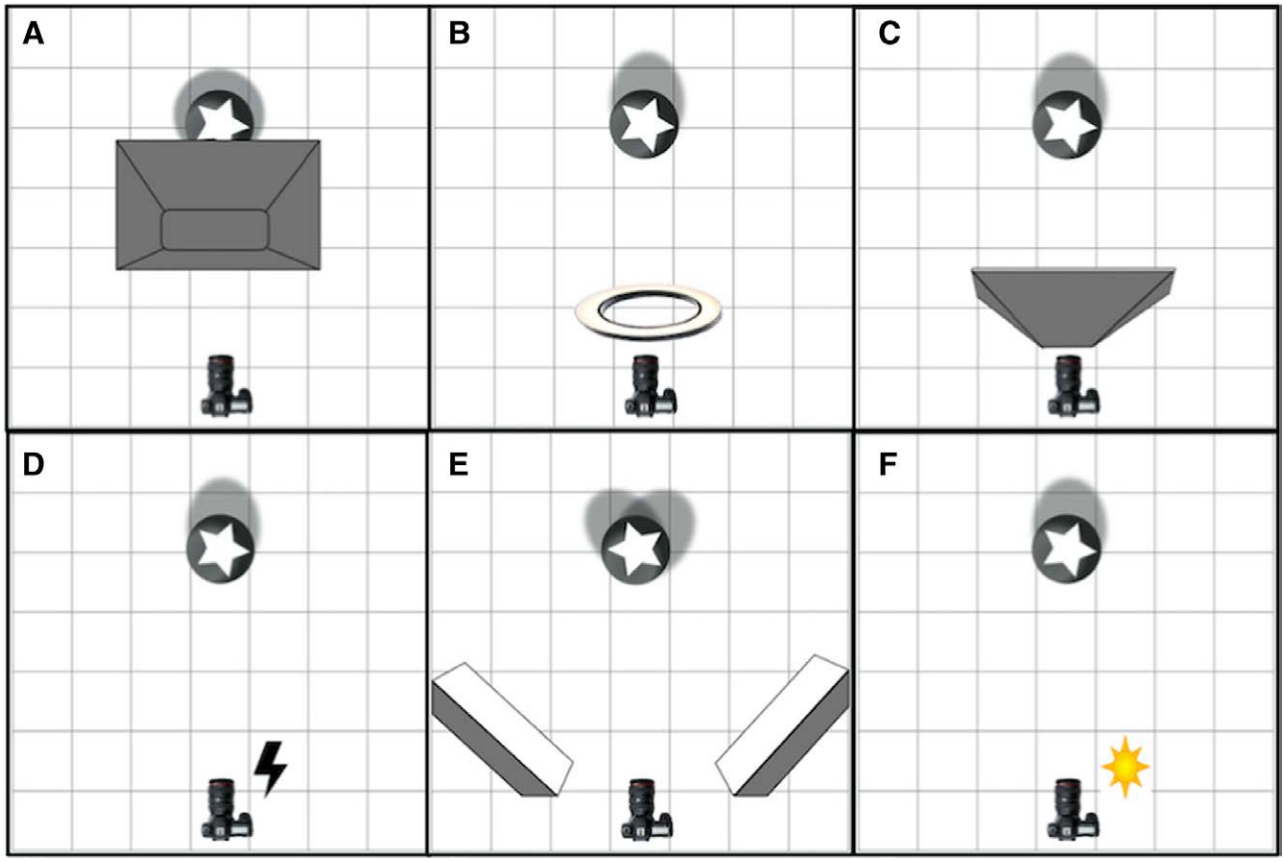

FIG. 1. Photographs were obtained under varied lighting conditions, which imparted different highlights and shadows. Diagram illustrating the six different lighting conditions studied, including (A) 90° overhead box light, (B) ring light, (C) 45° superior box light, (D) built-in camera flash, (E) 2 straight on box lights, each 45° from midline, and (F) natural light.

photographed during a single session. All images were obtained using an EOS Rebel T7 with zoom lens set at 80 mm (Canon Inc., Tokyo, Japan).

Subject photographs were imported into an online survey platform (Qualtrics 2020) and were displayed in random order. Survey respondents were recruited from Mechanical TURK marketplace (Amazon crowdsourcing platform) and instructed to rate the subject's attractiveness on a subjective scale of 0 to 10 (0 = highly unattractive; 10 = highly attractive).

Linear mixed models treating exposure and lighting condition as the fixed factor were used. Mixed ANOVA and pairwise comparisons with Bonferroni correction were used to compare between- and within-subject ratings. A p value of <0.05 was considered statistically significant.

RESULTS

Between the two experiments (variable exposure [5 photographs × 10 subjects × 200 survey respondents] and variable lighting conditions [6 photographs × 10 subjects × 200 survey respondents]) a total of 22,000 scored photographs were included in the analysis. Representative photographs of one subject are displayed in Figure 2.

There was no significant difference in the perceived attractiveness of a subject between the variably exposed photographs ($p = 0.07$–0.34; Fig. 3). The standardized means of attractiveness for each photo by exposure were within 0.10 standard deviation of the mean for all exposures, indicating that the variance for the rating of beauty for different photos was similar under different exposures (Fig. 4).

Lighting condition had a significant impact on perceived attractiveness ($F = 26.2$; $p < 0.001$). Subject attractiveness was rated poorer with the 90° overhead box light, whereas the 45° superior box light yielded greater scores of attractiveness relative to the other conditions (Fig. 5).

The reliability of crowdsource scorers was assessed using the generalizability theory. The greatest source of variability was the specific photograph rated, which accounted for 91.5% and 93.7% of the attractiveness score in both the exposure and lighting condition experiments, respectively.

DISCUSSION

Photograph exposure did not play a significant role in perceived attractiveness; however, the use of superior lighting at 45° to the subject was associated with greater perceived attractiveness while a 90° superiorly position light performed significantly worse. These results suggest that manipulation of highlights and shadows produced by different lighting direction is more closely associated with perceived attractiveness than the overall exposure per se.

Highlights and shadows play an important role in our interpretation of a scene or image.[11] For instance, the apparent shape of the nose can be significantly manipulated with asymmetric lighting, due to variable amounts of lateral shadowing.[12] Similarly, when the angle of incident light is increased ≥60°, greater shadowing results in accentuation of the depth of nasolabial folds.[9] Conversely, addition of a camera mounted flash minimizes shadows, leading to a perceived cosmetic improvement of the lower eyelids.[10]

We found the highest scores of attractiveness were achieved when the 45° overhead box light was used. This suggests that some degree of shadow from an elevated light source

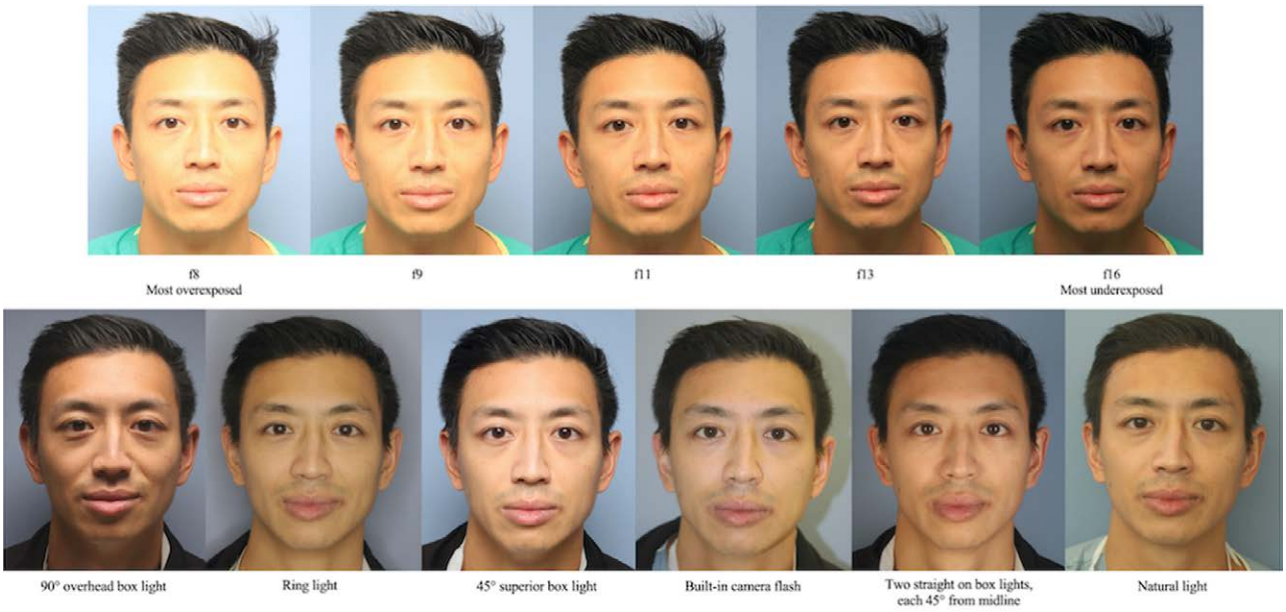

FIG. 2. Representative images of one subject in both the variable exposure and lighting condition experiments.

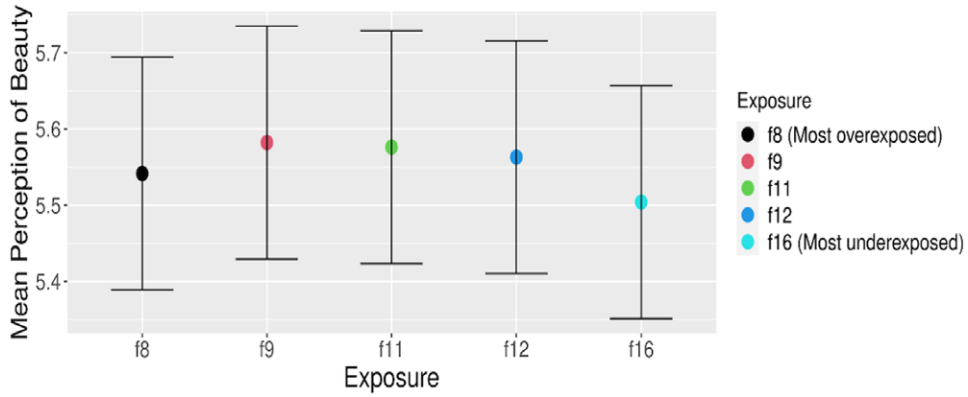

FIG. 3. Mean perception of attractiveness by variable photograph exposure.

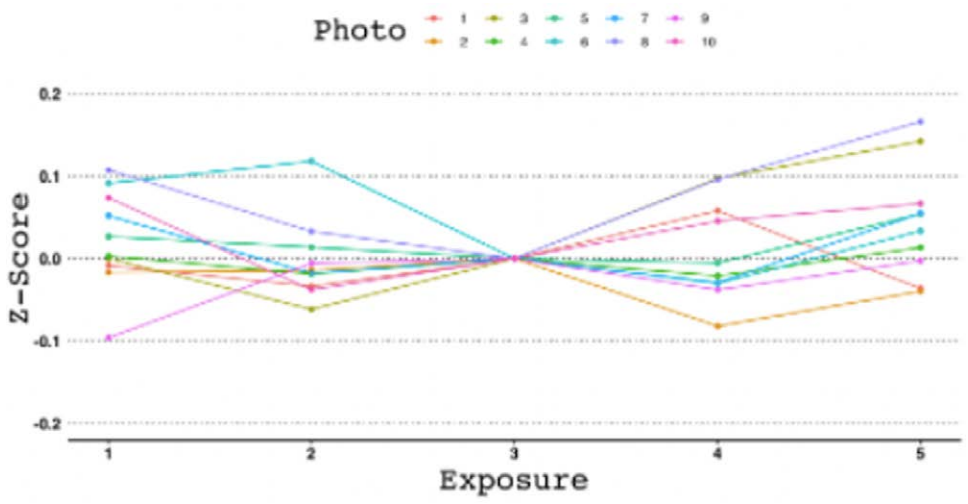

FIG. 4. Standardized means for rating of attractiveness for each photograph by exposure.

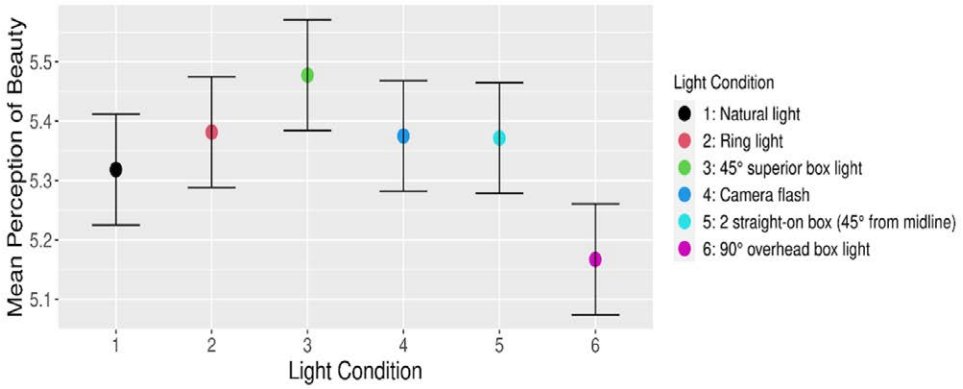

FIG. 5. Mean perception of attractiveness by variable lighting condition.

enhances facial contours in an advantageous way over the diffuse illumination achieved from incident light at eye level (2 box lights at eye level 45° from midline). In professional makeup artistry, contouring techniques take advantage of the harmony of highlights and shadows to enhance beauty. As the angle of incident light increases, with overhead lighting being the extreme example of this, the amount of shadowing also increases. We hypothesize that although the excessive shadowing imparted by overhead lighting is deleterious, conditions resulting in just enough shadow to emphasize facial features in an attractive manner, akin to the contrast imparted by makeup, are desirable. Though the sun's angle of illumination depends on latitude, for nearly half of the day, it sits 30° to 60° above the horizon. Thus, perhaps from an evolutionary standpoint, we have an ingrained preference for this illumination. In summary, the 45° superior box light appears to strike an optimal balance of highlights and shadows thus leading to an increase in perceived attractiveness.

In addition to the highlights and shadows imparted from angle, direction, and type of illumination, digital manipulation of photographs can also result in an altered representation of reality. Kandathil et al. found that selfies taken with snapchat filters were rated as more attractive, youthful, healthy, and feminine.[7] Similarly, subjects were rated as more attractive when an artificial tan had been applied in photoshop.[13] Even simple digital manipulations aimed at improving clarity or exposure can culminate in misleading alterations that are difficult to detect, and thus postacquisition alteration of clinical photographs should be avoided.[14]

Beyond the variables that can alter perceived attractiveness, several other important aspects of clinical photography should be taken into consideration. Authors have suggested that a monochromatic, nonreflecting background should be used, patient positioning should be adjusted to avoid unintentional off-axis images, and a standardized set of photographs/views should be obtained at each visit.[1–3] Although before and after photos used for patient education and advertising have traditionally been displayed as static images, either side by side or up and down, an animated, alteration flicker format (Graphics Interchange Format) may improve the ability of patients to detect subtle postprocedure changes.[15]

The present study is limited by the finite number of lighting conditions and exposures investigated. As there are a vast number of lighting configurations possible, it is conceivable that more than one may be considered "optimal." This study cannot confirm the presence of the best lighting condition among all possible orientations, and only comments on the relative scores obtained in the six conditions tested. Similarly, as we only examined photographs with exposures ≤2/3 stops from the aperture required to achieve optimal exposure, the effect of more drastically under- or overexposed photographs remains unknown. Finally, it is possible that the impression of expert observers may differ from that of crowdsourced participants.

In conclusion, the significant impact of lighting condition on perceived attractiveness underscores the importance of maintaining consistency in before and after photography. An appreciation for the nuances of clinical photography forms the foundation for acquiring high-quality images, thus optimizing patient education, improving self-assessment of outcomes, and increasing standardization throughout the published literature.

REFERENCES

1. Persichetti P, Simone P, Langella M, et al. Digital photography in plastic surgery: how to achieve reasonable standardization outside a photographic studio. *Aesthetic Plast Surg* 2007;31:194–200.
2. DiBernardo BE, Adams RL, Krause J, et al. Photographic standards in plastic surgery. *Plast Reconstr Surg* 1998;102:559–568.
3. Yavuzer R, Smirnes S, Jackson IT. Guidelines for standard photography in plastic surgery. *Ann Plast Surg* 2001;46:293–300.
4. Parker WL, Czerwinski M, Sinno H, et al. Objective interpretation of surgical outcomes: is there a need for standardizing digital images in the plastic surgery literature? *Plast Reconstr Surg* 2007;120:1419–1423.
5. Jones AL, Kramer RS. Facial cosmetics and attractiveness: comparing the effect sizes of professionally-applied cosmetics and identity. *PLoS One* 2016;11:e0164218.
6. Dayan S, Rivkin A, Sykes JM, et al. Aesthetic treatment positively impacts social perception: analysis of subjects from the HARMONY Study. *Aesthet Surg J* 2019;39:1380–1389.
7. Kandathil CK, Patel PN, Saltychev M, Most SP. Differences in social perceptions between digital single lens reflex camera and cell phone selfie images [published online ahead of print May 12, 2020]. *Facial Plast Surg Aesthet Med*. doi: 10.1089/fpsam.2020.0077.
8. Ward B, Ward M, Fried O, et al. Nasal distortion in short-distance photographs: the selfie effect. *JAMA Facial Plast Surg* 2018;20:333–335.
9. Hernandez CA, Espinal JM, Zapata DU, et al. The influence of different light angles during standardized patient photographic assessment on the aesthetic perception of the face [published online ahead of print May 13, 2021]. *Aesthetic Plast Surg*. doi: 10.1007/s00266-021-02314-3.
10. Cariello A, Viana GA, Osaki M, et al. Standardized clinical photography: the role of flash. *Ophthalmic Plast Reconstr Surg* 2012;28:e41–e42.
11. Pas SFT, Pont SC, Dalmaijer ES, et al. Perception of object illumination depends on highlights and shadows, not shading. *J Vis* 2017;17:2.

12. Strub B, Mende K, Meuli-Simmen C, et al. The frontal view of the nose: lighting effects and photographic bias. *Aesthet Surg J* 2015;35:524–532.
13. Chung VQ, Gordon JS, Veledar E, et al. Hot or not–evaluating the effect of artificial tanning on the public's perception of attractiveness. *Dermatol Surg* 2010;36:1651–1655.
14. Nouraei SA, Frame J, Nduka C. Uses and abuses of digital imaging in plastic surgery. *Int J Surg* 2005;3:254–257.
15. Akella SS, Goldstein T, Kumar S, et al. Changing in a GIF (Graphics Interchange Format): innovations in before and after photography. *Ophthalmic Plast Reconstr Surg* 2020;36:272–276.