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## Impact of Surgical Rejuvenation on Visual Processing and Character Attribution of Faces --Manuscript Draft--

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<b>Abstract:</b>	<p>Background</p> <p>This study considers observers' reflexive responses to the rejuvenated face, and how instinctive responses relate to subjective judgment. We investigated observer's reflexive perception of faces both pre- and post-surgical intervention during the early stages of visual processing. Subjective character attribution for all test images was also assessed by the same observers.</p> <p>Method</p> <p>40 frontal facial images of 20 patients portraying the pre- and post-operative high SMAS facelift along with variable concomitant procedures were studied. Nineteen lookzone regions were mapped post-hoc onto each image. 40 observers examined the images while an eye-tracking camera recorded their eye movements. Visual fixation data was recorded and analyzed. Observers also rated each image on the basis of 5 elemental positive character attributes.</p> <p>Results</p> <p>A statistically non-significant but coherent trend was identified with the surgical intervention resulting in greater attention being paid to the central triangle region of the face with reduction in attention to the facial periphery. Facial rejuvenation significantly increased the subjective character ratings of all five positively valenced attributes tested. Average age estimate of the photos decreased significantly from 54 years to 48.6 years (true average age of 57.4 years).</p> <p>Conclusions</p>

	<p>We provide data illustrating both reflexive as well as subjective responses to facial rejuvenation. Observers reported a more favorable impression of the treated faces, and evaluated them as being younger than their true age. A trend was detected for increased visual fixation of the central facial region following rejuvenation. Interpretation of these findings, and indication for further research is provided.</p>
<p><b>Additional Information:</b></p>	
<p><b>Question</b></p>	<p><b>Response</b></p>
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Dr. Jeffrey E. Janis

October 11, 2022

Editor-in-Chief

Plastic and Reconstructive Surgery Global Open

Dear Dr. Janis,

Please find our enclosed manuscript entitled “Impact of Surgical Rejuvenation on Visual Processing and Character Attribution of Faces” By Boonipat *et al* to be considered for publication as an original article in Plastic and Reconstructive Surgery Global Open.

As the prevalence of aesthetic surgeries continues to increase, understanding the impact of our work on patients’ interactions with the world is paramount. Our eye-tracking investigation of observers’ gaze on facial rejuvenation patient images achieves just that. In conjunction with observer-rated characteristics of patients, we can elucidate the way facial rejuvenation alters reflexive and conscious perception by others. We believe this unique use of eye-tracking is insightful to a broad array of surgical specialties to examine surgical outcomes from a subconscious lens.

We attest that the research described in this manuscript is original, has not been previously published, and is not being considered for publication elsewhere. The authors have no conflicts of interest to declare.

As Corresponding Author, I confirm that the manuscript has been read and approved for submission by all the named authors.

Thank you for your consideration.

Respectfully,

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<b>Impact of Surgical Rejuvenation on Visual Processing and Character Attribution of Faces</b>
<p><b>Question:</b> How does facial rejuvenation alter observer’s reflexive and subjective assessment of the patient’s face?</p>
<p><b>Findings:</b> Analysis of 40 SMAS facelift demonstrated that facial rejuvenation increases observers’ attention to the central triangle while decreasing attention to the facial periphery. Subjective ratings by observers demonstrated decreased estimate of average age and increased positive character attribution after surgery.</p>
<p><b>Meaning:</b> Rejuvenation surgery results in a more favorable, younger, impression of the treated faces as elucidated by eyetracking and subjective reporting by observers.</p>

# Impact of Surgical Rejuvenation on Visual Processing and Character Attribution of Faces

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**Short Running Head:** Impact of Facial Rejuvenation on Visual Processing

**Keywords:** Facial Rejuvenation Surgery, Face Lift, Eye-tracking, Facial Perception, High SMAS Facelift, Neck Lift, Fat Grafting, Brow Lift, and Blepharoplasty.

## **ABSTRACT**

### **Background:**

This study considers observers' reflexive responses to the rejuvenated face, and how instinctive responses relate to subjective judgment.

We investigated observer's reflexive perception of faces both pre- and post-surgical intervention during the early stages of visual processing. Subjective character attribution for all test images was also assessed by the same observers.

### **Method:**

40 frontal facial images of 20 patients portraying the pre- and post-operative high SMAS facelift along with variable concomitant procedures were studied. Nineteen lookzone regions were mapped post-hoc onto each image. 40 observers examined the images while an eye-tracking camera recorded their eye movements. Visual fixation data was recorded and analyzed. Observers also rated each image on the basis of 5 elemental positive character attributes.

### **Results:**

A statistically coherent but non-significant ( $p > 0.05$ ) trend was identified with the surgical intervention resulting in greater attention being paid to the central triangle region of the face with reduction in attention to the facial periphery. Facial rejuvenation significantly increased the subjective character ratings of all five positively valenced attributes tested. Average age estimate of the photos decreased significantly from 54 years to 48.6 years (true average age of 57.4 years).

### **Conclusions:**

We provide data illustrating both reflexive as well as subjective responses to facial rejuvenation. Observers reported a more favorable impression of the treated faces, and evaluated them as being younger than their true age. A trend was detected for increased visual fixation of the



central facial region following rejuvenation. Interpretation of these findings, and indication for further research is provided.

## Introduction

First impressions are largely determined by physical appearance and can contribute to a lasting positive perception in general.<sup>1,2</sup> Multiple studies have considered patient satisfaction following facial rejuvenation surgery and generally report favorable outcomes and an overall enhancement of youthful appearance.<sup>3,4</sup> However, few studies have evaluated observer impressions of patient appearance following such rejuvenative intervention. It is understood that observer impressions are formed rapidly, with initial visual processing of a face beginning within 170 milliseconds of exposure, and facial recognition estimated to occur as early as 300 milliseconds<sup>5-8</sup>. Tracking an observer's eye movements during facial inspection provides information about particular structural areas of reflexive interest or attraction. Accordingly, eye-tracking is a research modality that can highlight for patients and their providers areas of the face that are subconsciously considered of interest to others.<sup>5-9</sup> During rhytidectomy and related facial rejuvenation procedures, various areas of the face are targeted for improvement: forehead rhytids, brow position and contour, redundant eyelid skin, lid position and canthal angulation, glabellar lines, deepening of the nasolabial folds, jowls, cervicomental obliquity, etc. These aging cues can be perceived independently or holistically, but are being processed subconsciously by an observer in the initial moments upon encountering a face. The vantage point from which a face is viewed will presumably impact which telltale aging signs are of greatest interest to the observer (e.g., cervicomental angle seen best from profile view; nasolabial folds from frontal view). In the current study, we have tracked the eye movements of observers exposed to frontal images of 20 patients who underwent rhytidectomy along with a variable combination of ancillary rejuvenative interventions. This modality of evaluation serves as a proxy, representing reflexive observer detection of facial aging changes. Accompanying our

measurement of instinctive responses to the aging and rejuvenated face, we have also surveyed the subjective impressions of observers to these same facial images. Possible associations between the subliminal and reported responses were studied.

## **Methods**

### ***Study Participants***

The participants were divided into (i) stimulus group, and (ii) observer-rater group.

#### Stimulus group:

The stimulus group included 20 consecutive patients who underwent facial rejuvenation surgery from January to December of 2017. The patients were operated on by a single aesthetic surgeon (D.S.) at one private practice center. Signed informed consent was obtained for all images, as per protocol approved by our Institutional Review Board. Two images per patient were included in this study (i.e., a total of 40 images). Photographs were obtained before and at least 3 months after surgical rejuvenation. An image pair of a representative patient is shown in Figure 1.

#### Observer group:

Forty observer-raters were recruited from the general lay population in a city center. These participants consented to having their eyes tracked while observing 40 images that were randomly displayed on a computer screen. Thus, each image was viewed by 40 individuals. Visual acuity testing was also performed and 20/40 vision or better was required in each eye for inclusion (lens correction permitted). Observers' gender (13F and 27M) and age (mean= 41.9y, range= 16-72) was reported. After completion of the slideshow, the observers were asked to estimate the age of

the 40 patients depicted in the images, and then judge the faces employing a Likert scale of 1(least) to 7(most) for the following character attributes: attractiveness, trustworthiness, sociability, health, and capability. In order to provide the observers with visual anchors, sample open-source images of males and females representing extremes of the scale (based on authors' judgment) were presented at the beginning of each survey.

### ***Eye Tracking Protocol***

The 40 stimulus images portrayed pre- and post-operative photos of patients who underwent high SMAS facelift, with or without fat grafting, browlift, chin augmentation, lip augmentation, and upper and lower blepharoplasty. Photographs were obtained before and at least 3 months following the surgical intervention. Study images were presented to observers on a 17" flat screen computer monitor for a total of 6 seconds. Seven minutes was required for study participants to complete observation of the entire 40 image slideshow. A 3-second blank, black interval was displayed between images. No specific instructions were given to the observers other than to view the images freely. Quick Screen Capture software (version 3.0, Etrusoft, Kaysville, UT) was used to present PowerPoint (Microsoft, Redmond, WA) slideshows containing the image stimuli, and these were displayed in random order from one subject to another. An EyeTech TM4 desktop mounted, high resolution eye-tracking system was utilized (EyeTech Digital Systems, Mesa, AZ) which captures infrared light reflected off the cornea with a binocular data tracking rate of 30 Hz, and an accuracy of 0.5 degrees' visual angle. The low profile TM4 console was placed unobtrusively at the base of the computer monitor. Each participant's head was held stationary in an optometric chinrest 60 cm from the monitor. At that distance, and with the eye tracking system reporting an accuracy of +/- 0.5 degree visual angle,

the maximum eye tracking error is calculated to be +/- 5 mm. Even the smallest region of interest on the faces in the study, when projected onto the 17-inch monitor, measured at least 1.4 cm in each dimension, with an area of at least 2 cm<sup>2</sup>.

The eye tracking procedure commenced with a calibration sequence in which participants were asked to track a dot displayed randomly at nine different locations on the screen. The system was calibrated on a per subject basis.

Nineteen aesthetic regions of interest (“lookzones”) were hand-drawn onto each image using pre-determined anatomic landmarks used in advance of the study (Figure 2). The numbered look zones were consistent across all patients. The neck as well as nine matched bilateral facial zones were identified on each image, classified as: forehead (1,2); eye and brow (3,4); glabellar (5,6); lower lid (7,8); nasal dorsum (9,10); mid-cheek (11,12); nasal tip and alae (13,14); upper lip (15,16); lower lip, chin, mandible (17,18); and neck (19). The lookzones were overlaid onto the images post-hoc, thus were unseen by the observers. EyeTech’s Quick Link API software was used to compute real time data from the eye-tracking system which captured the X, Y position of the eye during each 33-millisecond interval. Fixation count and duration -- relative to each facial aesthetic lookzone -- was computed. A fixation was defined as a gaze duration of >100ms. All information was imported from Excel (Microsoft, Redmond, WA) files to SPSS v.22.0 (IBM, Armonk, NY), and analyzed in relation to the demographic/diagnostic details of the stimulus and observer groups.

## **Data Analysis**

All data analyses were conducted in SPSS v.22.0 (IBM, Armonk, NY). Visualization of the data was facilitated with Tableau version 8.3.3 (Tableau Software, Seattle, WA). Mean fixation counts

and fixation durations were computed across all 19 lookzones. The interaction effect of a variety of independent variables on lookzone fixation was analyzed using factorial ANOVA testing. Significance was set at the  $p < 0.05$  level.

## **Results**

### **Participant and procedural details:**

The 20 patients whose images were presented to observers had a mean age of 57.4 years old with a range from 41 to 70 years old (16 female, 4 male). Other concomitant procedures in addition to the rhytidectomy included: 14 patients with browlift, 16 patients with upper plus/minus lower blepharoplasty, 18 patients with fat grafting to the face, 4 patients with upper and/or lower lip augmentation with fat, and 3 patients with chin augmentation with implants (See **Supplementary Table 1**). The observers' age ranged from 16 to 72 years with a mean of 41.9 years (13 females, 27 males). All observers except for one had completed more than an 8<sup>th</sup> grade level education.

### **Proportion of total facial visual fixation, by lookzone:**

The eye tracking analysis uncovered interesting findings with respect to observers' unconscious, reactive responses to the patient images. With respect to the lookzones of the face, a similar regional distribution of visual attention was measured for the pre- and post-operative stimuli, with preferential attention paid to the region of the eyes and mouth, as expected (Figure 3). **A statistically coherent but non-significant ( $p > 0.05$ ) trend** was identified with the surgical intervention resulting in even greater attention being paid to the eye and brow, lower lid, upper lip, and nasal tip and alar regions (increases of 1%, 6.7%, 2.6%, and 12.4%, respectively), and a post-

intervention reduction in attention towards the forehead, glabella, mid-cheek, neck, nasal sidewall, and lower lip regions (reduction of 13.8%, 11%, 3.8%, 17.9%, 6.8%, and 2.2%, respectively).

### **Impact of surgical intervention on character attribution and estimation of age:**

Character attribution was broadly affected by the facial rejuvenation procedure. As demonstrated in Figure 4, the surgical intervention was found to increase the overall rating for all five-character attributes. The increase from pre- to post-operative ratings were as follows: attractiveness (3.34 to 3.90, 16.8% increase); capability (3.91 to 4.43, 13.3% increase); healthy (4.07 to 4.61, 13.3% increase); sociable (3.53 to 4.18, 18.4% increase); and trustworthy (3.85 to 4.20 (9% increase) (Figure 5). These changes were all statistically significant ( $p < 0.001$ ).

The observers estimated the average age of the patients in the study images to be 54 years (range 44.9-65.0) preoperatively and 48.6 years (range 40.5-59.5) postoperatively. The true mean age of the facial rejuvenation patients was 57.4 (range 41-68). The post-operative age estimate compared to the true age and to the pre-operative age estimate were both reduced in a statistically significant manner ( $p = 0.0001$  and  $0.0004$ , respectively). **Pre-operative age estimate compared to true age was statistically insignificant ( $p = 0.146$ ).**

## **Discussion**

In 2019, the most recent year of pre-COVID 19 statistics available from the American Society of Plastic Surgeons (ASPS), 261,987 facelifts, 181,024 neck lifts, 354,105 blepharoplasties, and 89,246 forehead lifts, were performed by ASPS member surgeons<sup>10</sup>. That represents a remarkable 105% increase in the total number of those particular procedures being reported relative to 5 years earlier in 2014<sup>11</sup>. These data underscore the increasing importance that the public places on the

projection of a youthful face. Accordingly, it is incumbent upon the plastic surgeon to understand the critical elements of facial aging that are most salient to the casual observer.

Human visual inspection of a face is instinctively drawn towards a central discriminating zone encompassing the ocular, nasal and oral regions<sup>12</sup>. However, when encountering a face affected by congenital or acquired deformity, observer attention is partially reallocated to areas perceived as anomalous. While patient self-assessment tools<sup>3</sup>, quantitative measurement scales<sup>4</sup>, and national procedural statistics all provide valuable clues as to patient priorities and the parameters of facial aging, none of those sources of information yield insight into observers' subconscious reaction to a face. Spontaneous visual fixation corresponds closely with observer cognitive attention<sup>13,14</sup>, and because humans intuitively detect structural outliers, the use of eye-tracking technology represents an objective means of measuring consequential facial differences. Due to the fact that eye-tracking data reflect instinctive responses, they bypass any confounding that might exist from the known divergence of explicit (reported) and implicit (latent) attitudes<sup>15,16</sup>.

In this study we tested whether the subliminal appraisal of facial aging is similar to what has been previously shown for other acquired facial irregularities such as skin lesions<sup>17</sup>, nasal distortion<sup>18</sup>, or facial palsy<sup>19</sup>. A two-part research question was: "Do regions of facial elastosis attract the reflexive visual attention of observers and, if so, does facial rejuvenative surgery reverse that objective phenomenon"? As an accompanying inquiry, we surveyed observers' subjective character attribution with regard to the same facial stimuli, searching for possible association between the objective and subjective measures.

Prior eye-tracking work by Liao et al. showed that when tasked with estimating age, observers focus more attention on the lower third of the face<sup>20</sup>, reflecting the joint impact of elastosis and



gravity. Moreover, despite the human instinct for outlier detection when viewing a face<sup>10</sup>, Cai et al. showed that more “experienced” observers (such as facial aesthetic surgeons) when asked to rate a face on the basis of beauty, directed their gaze more evenly across the face; uninitiated viewers were more naturally drawn to the central facial triangle<sup>26</sup>.

It stands to reason that an observer’s viewpoint also impacts gaze pattern. Huynh et al<sup>21</sup> compared visual fixation with respect to the lateral versus frontal perspectives of a face. They were able to discern a shift of observers’ primary focus from eye/nose/mouth (when viewing frontal) to eye/nose/cheek (when viewing lateral). Certain limitations of the study, however, restrict extrapolation of their findings to our work: (i) their image stimuli were not demographically characterized (the one representative image displayed is of a youthful face), (ii) they did not undertake a pre- versus post-operative eye-tracking comparison, and (iii) their viewing cohort had a mean age of 23.6 years. Recently, Frautschi et al ran a pre- and post-operative eye-tracking comparison of surgically rejuvenated faces and were able to detect significant experimental differences in gaze patterns of treated faces.<sup>22</sup> This was despite the fact that their protocol was less powered than ours (11 versus 20 patients imaged, 25 versus 40 observers), and their observers were also younger (mean 32.0 versus 41.9 years) which arguably would make them less sensitive to detecting age-related facial changes . **The sensitivity to facial feature based on age was investigated by Murray et al.**<sup>23</sup> The rate of adjunctive facial rejuvenative procedures in their study was notably lower than ours (e.g., browlift 18% versus 80%; blepharoplasty 63% versus 80%; lipofilling 36% versus 90%). They considered visual fixation relative to both aesthetic lookzones of the face as well as to 3 broad vertical regions. Observers viewed frontal, lateral, and oblique facial images, and from all three perspectives measured decreased visual attention paid to the neck and more to the middle third of the face in the postoperative cohort. In the current study, we

measured observer gaze patterns with respect to frontal images of patients both before and after they underwent facial rejuvenation. We also explored a possible association between reflexive gaze pattern and subjective character attribution relative to the pre- and post-operative facial images. The mean age of our patient group was 57.4 years, and of the observers was 41.9 years. All patients underwent a comprehensive facial rejuvenation including a high SMAS facelift procedure (100%), fat grafting (90%), bilateral upper plus/minus lower blepharoplasty (80%), and browlift (70%).

With respect to how observers' eyes tracked our experimental faces, a statistically coherent but non-significant ( $p > 0.05$ ) trend was identified with the surgical intervention spurring greater attention towards the expressive central triangle region of the face and a reduction in gaze directed towards the facial periphery. This suggests that observers subconsciously detect peripheral elastosis as a distracting structural anomaly. The lack of statistical significance in this finding may be explained by the fact that the comprehensive package of rejuvenative interventions performed in our study impacted a broad array of the facial lookzones considered, perhaps more so than in the Frautschi protocol where the dominant intervention was a rhytidectomy. Similarly, whereas prior eye-tracking studies focused more narrowly on targets such as cleft lip deformity<sup>10</sup>, nasal dorsal deviation<sup>23</sup>, or periorbital aging<sup>24</sup>, the suite of surgical procedures considered here altered the brow, periorbital region, nasolabial folds, marionette lines, lips, jowls and cervicomental region. It is reasonable to infer that such an extensive transformation of the face would provoke a holistic change in the pattern of observer visual fixation, countering the likelihood for detection of a prevailing measurable change in any one particular lookzone.

The other factor to consider -- alluded to above -- is observer perspective. As reflected in Figure 6, the lateral viewpoint may better highlight elastotic changes preoperatively in the cervicomental

region, as well as improvement achieved in that region following rhytidectomy. Our current protocol was presumably insensitive to those findings, arguing for further eye-tracking investigation in the future to analyze the effects of facial rejuvenation from various frames of viewer reference.

In terms of character attribution in response to faces, a large body of research suggests that observers' perceptual reactions are almost instantaneous, and that the factors impacting impression formation (e.g., age, gender, attractiveness, shape, lighting, skin tone, etc.) are multifactorial and challenging to parse.<sup>25-27</sup> While all five of the positively-valanced characteristics that we measured significantly increased with surgical rejuvenation, as seen in Figure 5, it is plausible that the attributes we considered are co-related. For example, the impression of "more attractive" might commingle with the notion of "more healthy" and "more trustworthy", whereas "more healthy" might align with "more attractive" and "more trustworthy", and so on. Nevertheless, it is notable that all 5 metrics were enhanced significantly and in tandem, along with a perceived reduction in the estimated age of the imaged faces from 54 years to 48.6 years (true average: 57.4 years). The pre-operative estimated age and the true age were not significantly different demonstrating a lack of baseline observer bias towards rating faces younger than their true age.

The presented findings are not without limitation due to study design. While the protocol was restricted to the evaluation of faces in repose, there is certainly a possibility that some subtle unintended expression of emotion was revealed by patients despite instructions to remain neutral. Potentially confounding elements which may subconsciously impact viewers' gaze include fine alterations in lighting or variation in accessory aesthetics such as hairstyle or makeup. Moreover, the patients were racially homogenous (all low Fitzpatrick skin types), which could limit the generalizability of our results. The most crucial limitation of our study may be the fact that we

considered only frontal facial images. It is highly likely that examination of oblique and profile views of aging faces will elicit alternative patterns of observer gaze since elastosis is manifested and detected differently within different zones of the face. Finally, attempting to study a cohort of patients undergoing rejuvenative procedures exclusively in the lower third of the face may allow for a more focused assessment of the impact of elastotic aging changes in that facial region. The impact of all these various factors not considered here could well serve as the focus for worthwhile future investigation.

Taken together, the findings reported here suggest that the changes of facial elastosis are perceived as structural outliers that lure observer attention away from the central discriminating features of the face, and are associated with a latent reduction in the assignment of positive character attributes. This information may assist surgeons and their patients to better understand the critical elements of facial aging that are most salient to the casual observer, thereby facilitating a more meaningful discussion around treatment options and benefits available.

## **Conclusion**

We provide data illustrating both reflexive as well as subjective responses to facial rejuvenation. Observers reported a more favorable impression of the treated faces, and evaluated them as being younger than their true age. A trend was detected towards increased visual fixation of the central facial region following rejuvenation. The impact of observer perspective was considered, and suggests the need for further research to refine our understanding of the perception of facial aging and the benefits of available corrective surgical interventions.

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## Legend

Figure 1 - Representative patient image before (left) and after (right) facial rejuvenation surgery.

Figure 2 – Representative image of the overlaid hand-annotated lookzones for four experimental images using predetermined anatomic landmarks. Nine matching zones were identified on each side of the face with one zone for the neck. They are classified as the following: forehead (1,2); eye and brow (3,4); glabellar (5,6); lower lid (7,8); nasal dorsum (9,10); mid-cheek (11,12); nasal tip and alae (13,14); upper lip (15,16); lower lip, chin, mandible (17,18); and neck (19).

Figure 3 – Distribution of observers' visual fixation spent in each lookzone as a percentage of the total time examining the image. Bilateral lookzones were grouped together for a total of 9 pairs, and the neck was considered as a single lookzone.

Figure 4 – Trends represented in Figure 3, above, are depicted graphically here. With effacement of forehead and cheeks rhytids, exposure of the periorbital area, and smoothing of the jawline and cervicomenal region, there was an inclination for observers' attention to be redirected to the

preferred central zones (shaded in green) and away from the more peripheral zones of the face (shaded in red).

Figure 5 – The facial rejuvenative surgical intervention was found to increase the overall rating for all five-character positive valenced attributes. \* Denotes  $p < 0.001$ .

Figure 6 – Lateral pre- and post-operative view of representative patient. The lateral perspective highlights a preponderance of visible change in the cervicomental region, whereas the forehead and periorbital changes are more apparent from the frontal orientation.

**Supplementary Table 1.** – Concomitant procedures frequency among the examined facial rejuvenation cohort





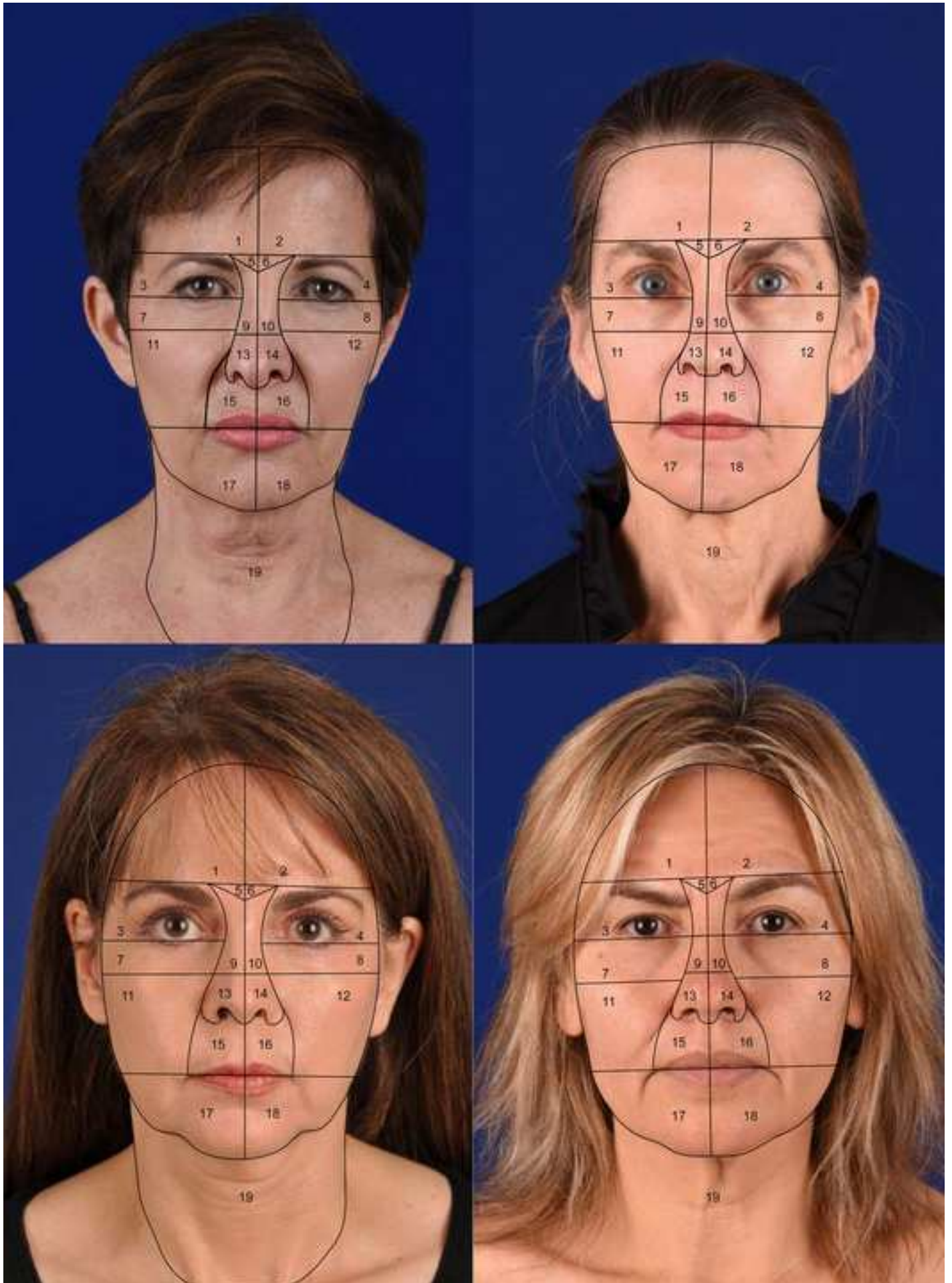
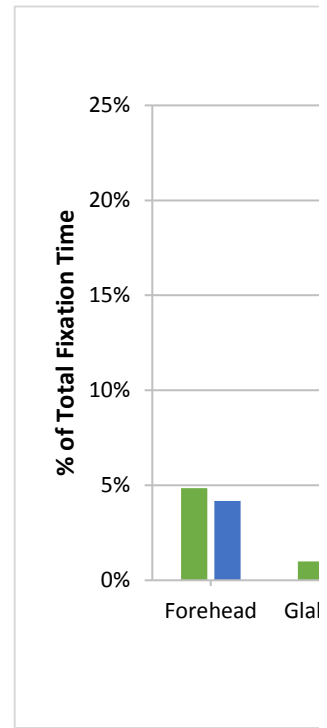


Figure 3



## Distribution of Visual Fixation

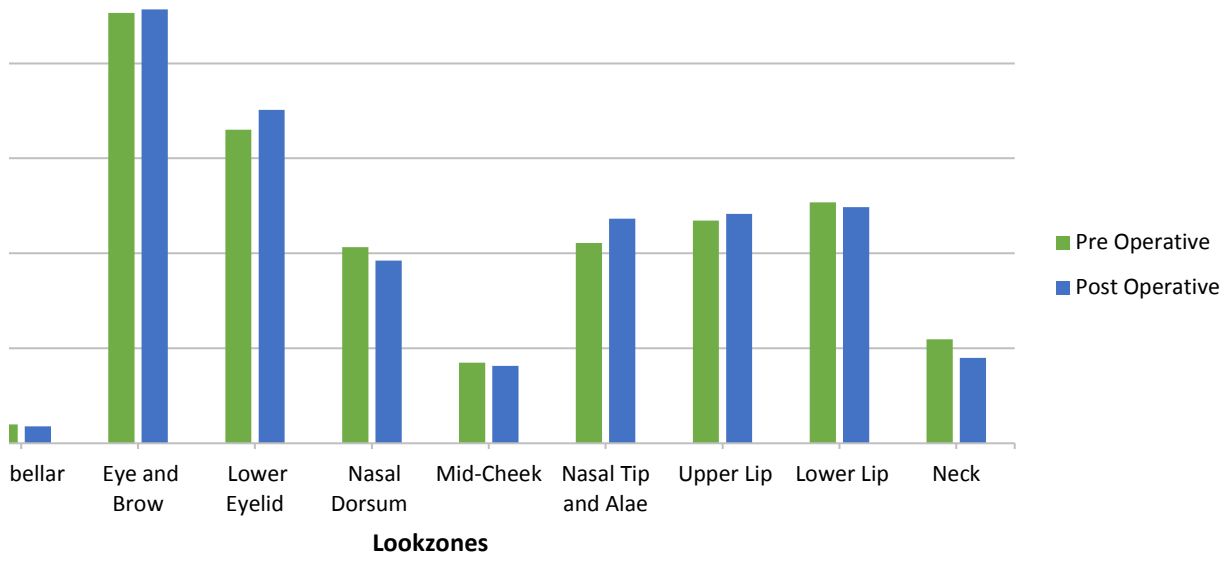
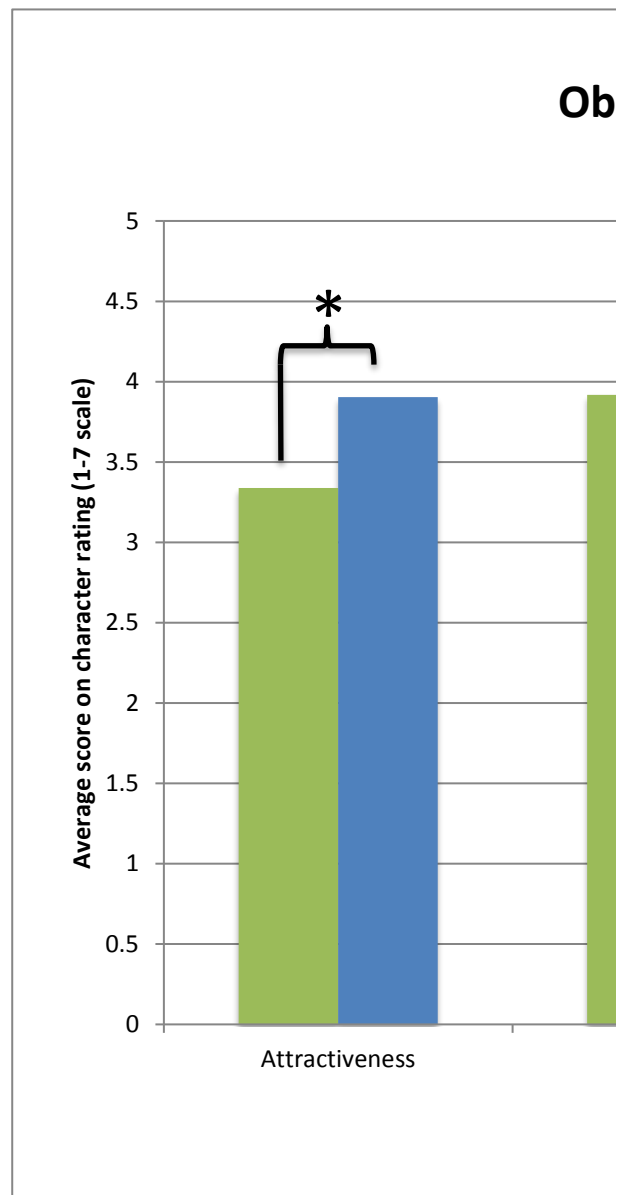






Figure 5

Stage	Avg. Age Estir	Attractiveness	Capable	Healthy
Pre Operative	54.0922253	3.33791485	3.91839878	4.07775684
Post Operativ	48.6652465	3.9043023	4.43372478	4.61277681



Sociable      Trustworthy  
3.5356274    3.85060161  
4.18451174    4.20090882

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## server Ratings of Perceived Character Attributes

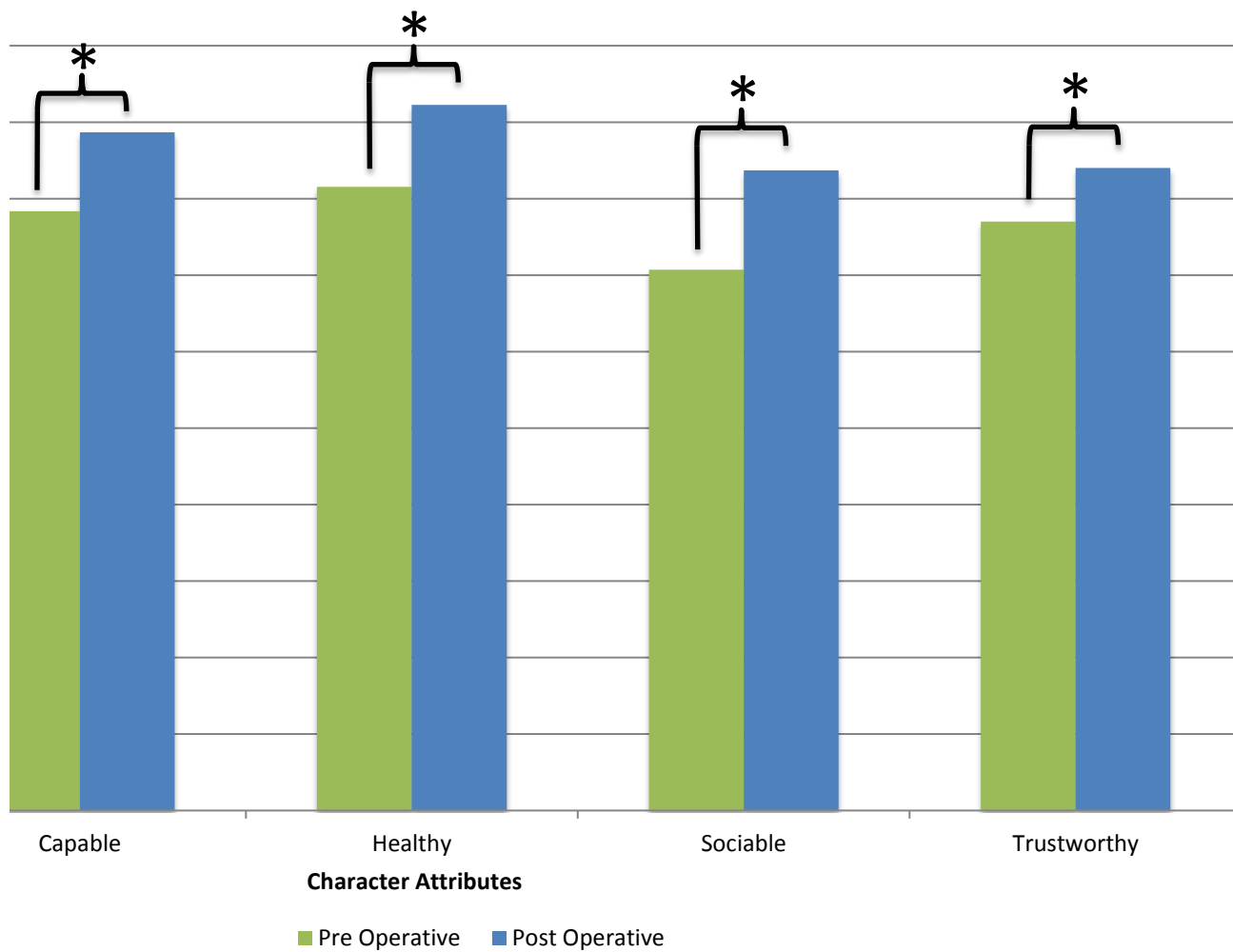






Figure 6

[Click here to access/download;Figure;Figure 6.jpg](#)



**Daniel I Shapiro, MD, PC**

**Patient Name: Rebecca Harrell**

**PATIENT PHOTOGRAPHIC AUTHORIZATION AND RELEASE**

I authorize Daniel I. Shapiro, M.D. and/or Shapiro Aesthetic Plastic Surgery, and/or Paradise Valley Skin Clinic, and/or his representative(s), to take pre, post and intra-operative photographs or videotapes of me and parts of my body, for confidential medical record purposes. I understand that such photographs will be used for my care, and that such photographs shall remain the property of Daniel I. Shapiro, M.D.

Print: Rebecca Harrell Signature: Rebecca Harrell

Date: \_\_\_\_\_ Witness: [Signature]

In addition, I authorize the use and disclosure of these photographs and/or videotapes, without compensation to me, to be used for the following marketing purposes: (Please **INITIAL** in the box marked YES to give permission or NO to opt out).

Initial Yes	Initial No	Medium
RH		Internet to include Website, Social Media, Email Marketing and/or Online Advertising
RH		Print Marketing
RH		Educational Lectures and Seminars

I understand that:

1. I may be identified by name in any of the media described above and I also understand that the photographs or videotapes will display features that identify me.
2. I have the right to revoke this authorization at any time. A revocation shall not affect any release of information made prior to revocation in reliance upon this Authorization. This authorization does not expire until revocation is received.
3. Dr. Shapiro may receive direct or indirect remuneration from the use of such photos.
4. The information disclosed under this Authorization, or some portion thereof, is protected by state law and/or the federal Health Insurance Portability and Accountability Act of 1996 ("HIPAA"). Any disclosure of information carries with it the potential for an unauthorized re-disclosure and the information may not be protected by applicable federal and/or state confidentiality rules.
5. A copy of this Authorization is valid as the original. I have received a copy of this Authorization. I may inspect or copy information to be used or disclosed under this authorization, as provided by federal and/or state law.

I release and discharge Dr. Shapiro from all liability, including liability for negligence that in any way arises out of:

any and all rights that I may have or may have had in the photographs or videotapes of me that I have authorized to be used and disclosed in this Authorization; and

any claim that I may have or may have had relating to such use and disclosure of those photographs, slides or videotapes of me, including any claim for payment in connection with any distribution or publication of them in any medium.

This Authorization is made as a voluntary contribution in the interest of public education and certify that I have read this Authorization and Release carefully and fully understand its terms.

Print: Rebecca Harrell Signature: Rebecca Harrell

Date: 02-11-22 Witness: [Signature]

**Patient Initials:** RH

# SHAPIRO

## AESTHETIC PLASTIC SURGERY AND SKIN CLINIC

### PATIENT PHOTOGRAPHIC AUTHORIZATION AND RELEASE

I authorize Daniel I. Shapiro, M.D. and/or Shapiro Aesthetic Plastic Surgery, and/or Paradise Valley Skin Clinic, and/or his representative(s), to take pre, post and intra-operative photographs or videotapes of me and parts of my body, for confidential medical record purposes. I understand that such photographs will be used for my care, and that such photographs shall remain the property of Daniel I. Shapiro, M.D.

Print: CARA HENNICK Signature: [Signature]

Date: 5-22-18 Witness: [Signature]

In addition, I authorize the use and disclosure of these photographs and/or videotapes, without compensation to me, to be used for the following marketing purposes: (Please **INITIAL** in the box marked YES to give permission or NO to opt out).

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[Initials]		<b>Print Marketing</b>
[Initials]		<b>Educational Lectures and Seminars</b>

I understand that:

- I will not be identified by name in any of the media described above and I also understand that in some circumstances the photographs or videotapes may display features that identify me.
- I have the right to revoke this authorization at any time. A revocation shall not affect any release of information made prior to revocation in reliance upon this Authorization. This authorization does not expires until revocation is received.
- Dr. Shapiro may receive direct or indirect remuneration from the use of such photos.
- The information disclosed under this Authorization, or some portion thereof, is protected by state law and/or the federal Health Insurance Portability and Accountability Act of 1996 ("HIPAA"). Any disclosure of information carries with it the potential for an unauthorized re-disclosure and the information may not be protected by applicable federal and/or state confidentiality rules.
- A copy of this Authorization is valid as the original. I have received a copy of this Authorization. I may inspect or copy information to be used or disclosed under this authorization, as provided by federal and/or state law.

I release and discharge Dr. Shapiro from all liability, including liability for negligence that in any way arises out of:

any and all rights that I may have or may have had in the photographs or videotapes of me that I have authorized to be used and disclosed in this Authorization; and

any claim that I may have or may have had relating to such use and disclosure of those photographs, slides or videotapes of me, including any claim for payment in connection with any distribution or publication of them in any medium.

This Authorization is made as a voluntary contribution in the interest of public education and certify that I have read this Authorization and Release carefully and fully understand its terms.

Print: CARA HENNICK Signature: [Signature]

Date: 5-22-18 Witness: [Signature]



## PATIENT PHOTOGRAPHIC AUTHORIZATION AND RELEASE

I authorize Daniel I. Shapiro, M.D. and/or Shapiro Aesthetic Plastic Surgery, and/or Paradise Valley Skin Clinic, and/or his representative(s), to take pre, post and intra-operative photographs or videotapes of me and parts of my body, for confidential medical record purposes. I understand that such photographs will be used for my care, and that such photographs shall remain the property of Daniel I. Shapiro, M.D.

Print: Luzmila Salmon Signature: \_\_\_\_\_

Date: 3/29/22 Witness: \_\_\_\_\_

In addition, I authorize the use and disclosure of these photographs and/or videotapes, without compensation to me, to be used for the following marketing purposes: (Please **INITIAL** in the box marked YES to give permission or NO to opt out).

Initial Yes	Initial No	Medium
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<b>Internet to include Website, Social Media, Email Marketing and/or Online Advertising</b>
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<b>Print Marketing</b>
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<b>Educational Lectures and Seminars</b>

I understand that:

1. I may be identified by name in any of the media described above and I also understand that the photographs or videotapes will display features that identify me.
2. I have the right to revoke this authorization at any time. A revocation shall not affect any release of information made prior to revocation in reliance upon this Authorization. This authorization does not expire until revocation is received.
3. Dr. Shapiro may receive direct or indirect remuneration from the use of such photos.
4. The information disclosed under this Authorization, or some portion thereof, is protected by state law and/or the federal Health Insurance Portability and Accountability Act of 1996 ("HIPAA"). Any disclosure of information carries with it the potential for an unauthorized re-disclosure and the information may not be protected by applicable federal and/or state confidentiality rules.
5. A copy of this Authorization is valid as the original. I have received a copy of this Authorization. I may inspect or copy information to be used or disclosed under this authorization, as provided by federal and/or state law.

I release and discharge Dr. Shapiro from all liability, including liability for negligence that in any way arises out of:

any and all rights that I may have or may have had in the photographs or videotapes of me that I have authorized to be used and disclosed in this Authorization; and

any claim that I may have or may have had relating to such use and disclosure of those photographs, slides or videotapes of me, including any claim for payment in connection with any distribution or publication of them in any medium.

This Authorization is made as a voluntary contribution in the interest of public education and certify that I have read this Authorization and Release carefully and fully understand its terms.

Print: Luzmila Salmon Signature: [Signature]

Date: March 29 2022 Witness: \_\_\_\_\_

# SHAPIRO

AESTHETIC PLASTIC SURGERY  
AND SKIN KLINIC

## PATIENT PHOTOGRAPHIC AUTHORIZATION AND RELEASE

I authorize Daniel I. Shapiro, M.D. and/or Shapiro Aesthetic Plastic Surgery, and/or Paradise Valley Skin Clinic, and/or his representative(s), to take pre, post and intra-operative photographs or videotapes of me and parts of my body, for confidential medical record purposes. I understand that such photographs will be used for my care, and that such photographs shall remain the property of Daniel I. Shapiro, M.D.

Print: Kellie Kelley Signature: *Kellie Kelley*  
Date: \_\_\_\_\_ Witness: \_\_\_\_\_

In addition, I authorize the use and disclosure of these photographs and/or videotapes, without compensation to me, to be used for the following marketing purposes: (Please **INITIAL** in the box marked YES to give permission or NO to opt out).

Initial Yes	Initial No	Medium
<i>KK</i>		<b>Internet to include Website, Social Media, Email Marketing and/or Online Advertising</b>
<i>KK</i>		<b>Print Marketing</b>
<i>KK</i>		<b>Educational Lectures and Seminars</b>

I understand that:

*No Name* *KK*

- I may be identified by name in any of the media described above and I also understand that the photographs or videotapes will display features that identify me.
- I have the right to revoke this authorization at any time. A revocation shall not affect any release of information made prior to revocation in reliance upon this Authorization. This authorization does not expire until revocation is received.
- Dr. Shapiro may receive direct or indirect remuneration from the use of such photos.
- The information disclosed under this Authorization, or some portion thereof, is protected by state law and/or the federal Health Insurance Portability and Accountability Act of 1996 ("HIPAA"). Any disclosure of information carries with it the potential for an unauthorized re-disclosure and the information may not be protected by applicable federal and/or state confidentiality rules.
- A copy of this Authorization is valid as the original. I have received a copy of this Authorization. I may inspect or copy information to be used or disclosed under this authorization, as provided by federal and/or state law.

I release and discharge Dr. Shapiro from all liability, including liability for negligence that in any way arises out of:

any and all rights that I may have or may have had in the photographs or videotapes of me that I have authorized to be used and disclosed in this Authorization; and

any claim that I may have or may have had relating to such use and disclosure of those photographs, slides or videotapes of me, including any claim for payment in connection with any distribution or publication of them in any medium.

This Authorization is made as a voluntary contribution in the interest of public education and certify that I have read this Authorization and Release carefully and fully understand its terms.

Print: Kellie Kelley Signature: *Kellie Kelley*  
Date: \_\_\_\_\_ Witness: \_\_\_\_\_

Reviewer Comment	Author Comments	Manuscript Revisions	Reviewer comments 2	Author comments	
<b>Reviewer 1:</b>			<b>Reviewer 1:</b>		
<p>Comment 1</p> <p>Consider the article's ABSTRACT (is it adequate?) and its TITLE (shorter titles featuring keywords prominently are more likely to be discovered). Consider TABLES, FIGURES, and VIDEOS (If the article already contains them, are they relevant and high-quality? If not, would the article be strengthened by adding them?)</p> <p>Thank you for submitting your manuscript for publication.</p>	<p>After reviewing our abstract, title, and figures, we believe the title is informative and contains the appropriate keywords to help discoverability. The figures demonstrate the surgical outcomes well, as well as easily conveying the messages of our findings and areas of interest for the reader.</p>		<p>Thank you for your revised manuscript. You have addressed our reviewers' questions and comments satisfactorily. I look forward to your continued study of this interesting topic.</p>	<p>Thank you for the comments</p>	
<p>Comment 2</p> <p>The statement within the abstract regarding the results does not follow the data you are reporting but rather confuses</p>	<p>Thank you, we appreciate how the wording could be confusing, we have altered the text in the locations where that statement was made.</p>	<p>We have changed the statement to "A statistically coherent but non-significant (<math>p&gt;0.05</math>) trend" to underscore that it is not significant but the trend was still observed.</p>			

<p>the reader whether there is statistically significant difference or not. Please change the statement and be more precise about the results.</p>					
<p>Comment 3 Although your association of positive visual processing and character attribution after facial rejuvenation surgery is logical, you have not clearly defined what is attracting the observers gaze to different parts of the face before and after surgery. Is it the view presented, or are the positive and/or negative differences in appearance etiologic? Are one's eyes attracted to deformity or beauty in the same way and</p>	<p>We appreciate this comment in helping to further tease out the message of our findings. We state in the discussion "...surgical intervention spurring greater attention towards the expressive central triangle region of the face and a reduction in gaze directed towards the facial periphery. This suggests that observers subconsciously detect peripheral elastosis as a distracting structural anomaly." We argue here that the</p>				

<p>how can they be differentiated? Why would the central part of the face, notably the nose and mouth, areas which should not change after surgery, engage ones attention differently pre and postoperatively?</p>	<p>abnormalities in the face with respect to elastosis and other age-related changes are the distracting feature causing pre-operative attention to be focused away from the central triangle. After surgery there is less attention in these regions as they are no longer deformed or pulling attention away from the commonly viewed central triangle. We cite how this is similar to the study done by Frautschi in which post-operatively the middle third of the face increased in gaze and the lower third decreased. We then argue that our findings were not significantly increased for one lookzone relative to another due to the extensive</p>				
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	<p>transformation in many regions of the face with facial rejuvenation. The general change then would be a decrease in attention to the previously “deformed” neck and periphery with now attention being holistically spread across the central triangle. In particular, the eyes and mouth would be focused on the most as psychologically this is where humans examine the face most in-depth. If the distracting peripheral areas are rectified during surgery, then the eye will return to a more balance examination of the face with focal points on the eyes and mouth.</p>				
--	---	--	--	--	--

<p>Comment 4 Did the authors notice any trends when comparing patients who had different adjunctive procedures? It would be of interest to compare the results of those who did not undergo eyelid and brow surgery and just had lower face and neck lifts.</p>	<p>This is another important question which prompts the necessity for further research. Among our cohort, only two patients did not undergo a browlift or blepharoplasty surgery. This would not be a large enough cohort to provide meaningful data for this study. It does provide an area where future research may be done but our aesthetic surgeon seldom provides neck lift and lower face procedures without concomitant upper face procedures.</p>	<p>We have added a table which outlines the concomitant procedures</p>			
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<p>Comment 5 I applaud your interest in this field of research and your beautiful operative results but suggest the authors add profile and three quarter views and repeat the reflexive part of the study to provide more comprehensive information on your visual data. Additionally, individuals undergoing facial rejuvenation care about how they're perceived but are more motivated by their own concerns. It would be interesting to see how the patients' respond to their pre and postoperative images.</p>	<p>We would like to thank the reviewers again for their thoughtful comments on our work. We absolutely agree with your evaluation of the limitations in assessed views. We feel it would be informative to future studies to include oblique and profile views of the patients. At this time, we are unable to re-enroll the same 40 observers to examine these facial profiles. Without the original 40 observers, we would be introducing unknown bias into the findings which lends us to opt for further research to include these other views relative to impacting the</p>				
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quality of our current data. We also agree that the patients innate reflexive response to their images would be an interesting aspect to study. This would only be attainable if done directly after surgery before the patient saw their rejuvenative face. As well, the pre-operative analysis might not be truly reflexive as the patients are well aware of their "flaws" and often comment that they fixate on them. This might result in them paying markedly more attention to the altered peripheral zones of the face relative to an "unprimed"

	<p>observer. This would be interesting to study, in fact, but we believe out of the scope of this particular project. Examining the psychology of patients undergoing rejuvenative procedures would be interesting: e.g., evaluating one another's images (reducing bias by not examining own's own) and comparing them to naïve controls. Again, we believe this is an avenue for further investigation and too extensive an addition for the current study.</p>				
<b>Reviewer 2:</b>					
<p>Comment 1 Please give further details about how the</p>	<p>Thank you for this suggestion. This would be helpful for</p>	<p>We added the following descriptors in the text: "The patients were operated on by a</p>			

<p>patients from the stimulus group were selected: single center, multiple centers, random selection.</p>	<p>readers in understanding our methodological process. We believe that the description of "20 consecutive patients between Jan and Dec of 2017" indicates that they were all the available patients within the given timeframe (non-random but not specifically selected).</p>	<p>single aesthetic surgeon at one private practice center".</p>			
<p>Comment 2 You stated "At that distance, and with the eye tracking system reporting an accuracy of +/- 0.5 degree visual angle, the maximum eye tracking error is calculated to be +/- 5 mm.", however, since the fovea is approximately 1.0 mm in diameter with a 3-degree visual angle, Isn't the</p>	<p>Thank you for this question. We reviewed it with our colleague who specializes in the eye tracking technology. He stated that the visual angle subtended by the fovea is 1 degree, not 3. The macula is 3-5mm surrounding the fovea, so the parafovea subtends a visual angle of</p>				

tracking error too much for the usual saccadic movement of the eye	3-5 degrees or a circle with a radius of 30-50mm at a distance of 2-3 feet. Saccades normally move a considerable distance away from the central fixation especially in the viewing of faces. Therefore, the eye tracking technology is sufficiently accurate to track the observer's gaze.				
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<p>Comment 3</p> <p>There are multiple statements within the results section regarding the surgical intervention itself that could be summarized in a table as they are not that relevant for the purpose of your study. Please revise.</p>		<p>We have added a supplemental table which outlines key patient concomitant procedures for readers to review.</p> <table border="1" data-bbox="657 1281 1047 1827"> <thead> <tr> <th colspan="2" style="text-align: center;"><b>Supplementary Table 1.</b></th> </tr> <tr> <th style="text-align: center;"><i>Procedures</i></th> <th style="text-align: center;"><b>N (% of Total)</b></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;"><i>High SMAS Facelift</i></td> <td style="text-align: center;">20 (100)</td> </tr> <tr> <td style="text-align: center;"><i>Browlift</i></td> <td style="text-align: center;">14 (70)</td> </tr> <tr> <td style="text-align: center;"><i>Blepharoplasty</i></td> <td style="text-align: center;">16 (80)</td> </tr> <tr> <td style="text-align: center;"><i>Fat Transfer</i></td> <td style="text-align: center;">18 (90)</td> </tr> <tr> <td style="text-align: center;"><i>Lip Augmentation</i></td> <td style="text-align: center;">4 (20)</td> </tr> </tbody> </table>	<b>Supplementary Table 1.</b>		<i>Procedures</i>	<b>N (% of Total)</b>	<i>High SMAS Facelift</i>	20 (100)	<i>Browlift</i>	14 (70)	<i>Blepharoplasty</i>	16 (80)	<i>Fat Transfer</i>	18 (90)	<i>Lip Augmentation</i>	4 (20)			
<b>Supplementary Table 1.</b>																			
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<i>Blepharoplasty</i>	16 (80)																		
<i>Fat Transfer</i>	18 (90)																		
<i>Lip Augmentation</i>	4 (20)																		

<p>Comment 4 Regarding the statement "The post-operative age estimate compared to the true age and to the pre-operative age estimate were both reduced in a statistically significant manner (p=0.0001 and 0.0004, respectively." Does this mean observers could be skewed or predisposed to provide a younger age for all photos? Please provide a statement about this within the discussion section.</p>	<p>This is an interesting thought that we had not included. On further data analysis the comparison of pre-operative age estimate relative to the true age was insignificant at p=0.146.</p>	<p>We included a statement in the results (Pre-operative age estimate compared to true age was statistically insignificant (p=0.146).) As well as in the discussion: "The pre-operative estimated age and the true age were not significantly different demonstrating no bias in the observers to rate faces younger than their true age".</p>	<p>Please add a statement accompanying the reference you added</p>	<p>Thank you for the comments. The following statement was added: The sensitivity to facial feature based on age was investigated by Murray et al.</p>	
<p>Comment 5 Could you please provide the relevant literature or</p>	<p>Thank you for the comment. After reviewing the literature, we believe that</p>	<p>We have added the following reference. Murray JE, Halberstadt J, Ruffman T. The face of aging: sensitivity to facial feature relations changes with age. Psychol Aging.</p>			



<p>research you made to provide the following statement: "...their observers were also younger (mean 32.0 versus 41.9 years) which arguably would make them less sensitive to detecting age-related facial changes."</p>	<p>older individuals do have greater sensitivity to detecting age related changes as individuals fixate on aging changes making them more attune to aging changes in others compared to younger observers.</p>	<p>2010 Dec;25(4):846-50. doi: 10.1037/a0019864. PMID: 20677879.</p>			
<p>Comment 6 Again, please correct the following statement: "...a statistically non-significant but coherent trend was identified..." as the terminology and syntax of the phrase might confuse the reader.</p>		<p>Changed to: a statistically coherent but non-significant (<math>p&gt;0.05</math>) trend</p>			
<p>Comment 7 As a personal opinion I would focus the discussion of your findings on how the holistic change of true facial</p>	<p>Thank you for this suggestion. After reviewing our discussion, we believe that the purpose of our study (to characterize how human</p>		<p>Please include some phrases within the discussion section about the explanations you gave to our comments.</p>	<p>Thank you for the comments. We are not completely certain which comments the</p>	

<p>rejuvenation might affect the eye tracking of postop pictures, meaning that a comprehensive surgical approach can actually fool the observer's eye to detect a specific facial change. The current discussion is full of information that does not provide any more useful data about the purpose of your study.</p>	<p>gaze and character attribution changes in response to facial rejuvenation) was explained in a holistic manner in that we described the shifts to and from areas of aging/elastosis and the expressive central triangle ("With respect to how observers' eyes tracked our experimental faces, a statistically coherent but non-significant (<math>p&gt;0.05</math>) trend was identified with the surgical intervention spurring greater attention towards the expressive central triangle region of the face and a reduction in gaze directed towards the facial periphery. This suggests</p>		<p>We believe these explanations are important for the reader to better understand your manuscript and its results.</p>	<p>reviewer #2 specifically is referring to. We believed we have incorporated each of their comments and our response into the manuscript previously.</p>
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that observers subconsciously detect peripheral elastosis as a distracting structural anomaly”). We also commented, in reference to the fact that a suite of rejuvenative interventions were often carried out “It is reasonable to infer that such an extensive transformation of the face would provoke a holistic change in the pattern of observer visual fixation, countering the likelihood for detection of a prevailing measurable change in any one particular lookzone”. As it currently stands, with the additional changes made from the reviewers’ suggestions we feel the discussion has outlined well

	<p>the purpose and meaning of the study data.</p>				
<p>Comment 8 Please provide a full paragraph about the limitations of your study, including confounders and biases. Even discuss the shortcoming of not being able to reject the null hypothesis of your study.</p>		<p>The following paragraph was added to the end of the discussion:</p> <p>The presented findings are not without limitation due to study design. While the protocol was restricted to the evaluation of faces in repose, there is certainly a possibility that some subtle unintended expression of emotion was revealed by patients despite instructions to remain neutral. Potentially confounding elements which may subconsciously impact viewers' gaze include fine alterations in lighting or variation in accessory aesthetics such as hairstyle or makeup. Moreover, the observer and patient groups were racially homogenous (all low</p>			

		<p>Fitzpatrick skin types), which could limit the generalizability of our results. The most crucial limitation of our study may be the fact that we considered only frontal facial images. It is highly likely that examination of oblique and profile views of aging faces will elicit alternative patterns of observer gaze since elastosis is manifested and detected differently within different zones of the face. Finally, attempting to study a cohort of patients undergoing rejuvenative procedures exclusively in the lower third of the face may allow for a more focused assessment of the impact of elastotic aging changes in that facial region. The impact of all these various factors not considered here could well serve as the focus for worthwhile future investigation.</p>			
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“Impact of Surgical Rejuvenation on Visual Processing and Character Attribution of Facial  
Aging”

**Supplementary Table 1.**

<i>Procedures</i>	<b>N (% of Total)</b>
<i>High SMAS Facelift</i>	20 (100)
<i>Browlift</i>	14 (70)
<i>Blepharoplasty</i>	16 (80)
<i>Fat Transfer</i>	18 (90)
<i>Lip Augmentation</i>	4 (20)
<i>Chin Augmentation</i>	3 (15)