Visual Attention, Bias, and Social Dispositions Toward People with Facial Anomalies: A Prospective Study with Eye-Tracking Technology

Dillan F. Villavisanis[1,2], Clifford I. Workman[2], Zachary D. Zapatero[1,2], Giap H. Vu[1,2], Stacey Humphries[2], Daniel Y. Cho[1], Jordan W. Swanson[1], Scott P. Bartlett[1], Anjan Chatterjee[2], Jesse A Taylor[1]

[1] Division of Plastic & Reconstructive Surgery, Children's Hospital of Philadelphia, Philadelphia, PA

[2] Penn Center for Neuroaesthetics, Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA

Corresponding author:
Jesse A. Taylor, MD, FACS, FAAP
Peter Randall Endowed Chair and Chief
Division of Plastic & Reconstructive Surgery
Children's Hospital of Philadelphia
3401 Civic Center Blvd
Philadelphia, PA 19104 USA
jataylor@gmail.com

Financial Disclosure Statement: The authors have no financial interest to declare in relation to the content of this article.

Presentation: An abstract describing these results was accepted to the American Cleft Palate-Craniofacial Association (ACPA) 79th annual meeting in Fort Worth, TX, planned for March 29 – April 2, 2022.

Short Running Head: Facial Anomalies, Visual Attention, and Bias

Abstract

Background: Facial attractiveness influences our perceptions of others. People with beautiful faces reap societal rewards (“beautiful-is-good” bias) whereas those with anomalous faces encounter penalties (“anomalous-is-bad” bias). The purpose of this study was to determine how visual attention of viewers is modulated by their biases and social dispositions toward people with facial anomalies.

Methods: Sixty subjects completed tests evaluating implicit bias, explicit bias, and social dispositions before viewing publicly available images of pre- and postoperative patients with hemifacial microsomia. Eye-tracking was used to register visual fixations. Linear mixed effect models were used to evaluate whether pre- vs. postoperative status and biases or social disposition scores interacted to influence participant visual fixations.

Results: Participants with higher implicit bias scores fixated significantly less on the cheek and ear region preoperatively ($p = 0.004$). Participants with higher trait empathy scores in empathic concern and perspective taking fixated more on the forehead and orbit preoperatively ($p = 0.045$) and nose and lips ($p = 0.027$) preoperatively, respectively. Explicit bias and other social disposition scores did not significantly influence visual attention.

Conclusions: Participants with higher levels of implicit bias deployed less visual attention to anomalous facial anatomy, while participants with higher levels of IRI empathic concern and perspective taking spent more visual attention on normal facial anatomy. Levels of bias and social dispositions such as empathy influence how laypeople look at those with facial anomalies and provide insights into mechanisms that may underly the “anomalous-is-bad” bias.

Introduction

Our faces are important for forming impressions and have an impact on perceptions of social characteristics (Mazzaferro 2017). Previous studies characterized relations between facial beauty and positive character traits, including perceived health and trustworthiness (Dion 1972, Eagly 1991). Recent research has reported associations between facial anomalies and negative social characteristics as well as higher levels of bias. Collectively, the social penalties associated with facial anomalies have been described as the “anomalous-is-bad” bias (Hartung 2019, Jamrozik 2019, Workman 2021a).

Assessment of visual attention provides unique insight into uninhibited behavior (Lim 2013). Eye-tracking technology has been increasingly used in the past decade to evaluate how people deploy visual attention toward those with facial differences (Asaad 2020). Studies generally find that visual attention is drawn toward anomalous anatomy (Haworth 2015), and that the degree of visual attention correlates with the severity of the pathology or anomaly (Meyer-Marcotty 2010). Hemifacial microsomia (HFM) is an optimal condition for studying gaze patterns because of its effects on specific facial regions, most commonly the mandible, chin, and ear (Santamaría 2008).

Recent work has implicated certain neuroanatomic structures when viewing others with facial anomalies. Laypersons with high levels of implicit bias toward those with facial anomalies demonstrated increased amygdala reactivity (Workman 2021a). While previous studies have used eye-tracking to characterize visual attention toward patients with craniofacial anomalies, visual attention has not been analyzed alongside assessments of biases and other social dispositions. This study aimed to characterize associations between visual attention patterns and implicit and explicit biases as well as social dispositions toward people with facial anomalies. We hypothesized that visual attention toward people with facial anomalies differs as a function of implicit bias. Specifically, we predicted visual attention would be directed away from areas of facial anomalies in those with high levels of implicit bias.

Methods

Study Population: For this prospective study, participants were recruited through the University of Pennsylvania MindCORE SONA, a system used to recruit members of the University of Pennsylvania and members of the Philadelphia metropolitan area for research studies. Participants completed a pre-screening form that assessed eye-tracking study ineligibility, including the presence of medical devices impacted by infrared light and a past medical history of photogenic epilepsy. Participants were 18 years of age or older, spoke English, and had no major visual impairments. Participants were compensated $20 USD per hour, and study visits were on average one hour in duration. At the beginning of the in-person study visit, participants completed written informed consent, where the study risks, benefits, and aims were described. This study was approved by the Institutional Review Board at the University of Pennsylvania Perelman School of Medicine.

Social Dispositions: Before the in-person study visit, eligible subjects provided demographic information and completed surveys to assess social dispositions: Interpersonal Reactivity Index (IRI) (Davis 1980), Procedural and Distributive Just World Beliefs Scale (JWBS) (Lukas 2011), Social Dominance Orientation Scale (SDO) (Sidanius 2001), and Three-Domain Disgust Scale (TDDS) (Tybur 2009).

The IRI assessed empathic concern (assessing feelings of sympathy and concern for others who are less fortunate) and perspective-taking (assessing tendency to adopt the psychological point of view of others) using a 1 – 5 scale of “does not describe me well” to “describes me very well” (Davis 1980). The JWBS assessed “procedural” and “distributive” just world beliefs about others using a 1 – 7 Likert scale (Lukas 2011). The SDO measured support for social hierarchy and the desire for in-group superiority relative to out-groups (Sidanius 2001). The TDDS assessed domains of pathogen (e.g., stepping on dog poop), moral (e.g., deceiving a friend), and sexual (e.g., hearing two people having sex) disgust (Tybur 2009).

Eye-Tracking and Stimuli: Participants in this study viewed seventeen publicly available front-facing pairs of patients pre- and post- corrective jaw surgery for HFM. Images were standardized in size and applied to black backgrounds (Workman 2021b). Images were presented in right-to-left and left-to-right orientation to correct for left gaze bias and to improve statistical power (Alpers 2007, Alpers 2008, Meyer-Marcotty 2010, Meyer-Marcotty 2011, Quast 2018).

Participant visual fixations were captured with the Tobii Pro Nano eye tracker. Participants completed two trials of an eye-tracking task with brief calibration (about 60 seconds) before each run. Calibration for this experiment involved tracking targets to nine locations on the screen – four outermost corners, four corners more central to the screen, and the central most point of the screen. A total of 68 images were presented for five seconds each in a pseudo-randomized fashion, both regarding order of appearance and the side of the screen on which it appeared (Meyer-Marcotty 2011, Warne 2019). Participants were instructed to look at a centralized white “+” on a black background between each image for 1.5 seconds to recenter gaze prior to the subsequent image. Each trial was designed to last about ten minutes total.

Four areas of interest (AOIs) were defined on each face: cheek and ear, forehead and orbit, mandible and chin, and nose and lips. The number of visual fixations was quantified in each AOI. Visual fixations were defined as a visual gaze in a single location for 200 ms or longer.

Implicit Association Test and Explicit Bias Questionnaire: Participants completed an Implicit Association Test (IAT) in a standard manner (Greenwald 2006). This procedure consists of seven parts, where they associated words with positive connotations with non-anomalous faces and words with negative associations with anomalous faces (Greenwald 2006). First, participants pressed keys to categorize faces as anomalous or typical. Second, using the same keys, participants categorized words as “good” (e.g., happy) or “bad” (e.g., sickening). Third, participants used the same keys to categorize both faces and words (e.g., anomalous faces and good words, typical faces and bad words). The fourth part replicated the third. In parts five through seven, the mapping between faces and keys was swapped (e.g., such that anomalous faces were paired with bad words, and typical faces were paired with good words).

The average reaction time when associating anomalous faces with bad words (and typical faces with good words as in part seven) was subtracted from the average reaction time when associating anomalous faces with good words (and typical faces with bad word as in part four). This difference was divided by the standard deviation to calculate the IAT score (Greenwald 2003). Participants who were faster at associating anomalous faces with bad words had positive IAT scores, indicating implicit bias.

Finally, participants completed an explicit bias questionnaire (EBQ), a 33-item questionnaire about people with facial anomalies using a 1 – 7 Likert scale (Supplemental Table 1).

Statistical Analyses: Linear mixed effects models (LMEMs) tested whether locations of participant fixations were affected by surgical correction of HFM and influenced by IAT, EBQ, or social disposition scores. Social dispositions included in the LMEM analyses were selected based on previous research (Hartung 2019, Workman 2021a) and included: IRI empathic concern, IRI perspective taking, SDO, JWBS procedural and distributive towards others, and TDDS pathogen disgust.

Bias and social disposition data were assessed for normality with Shapiro-Wilk tests. Data that were not normally distributed were transformed with Tuckey Ladder of Powers in RStudio, a validated method to transform data to achieve normal or near-normal distributions (Dang 2014).

Null models were estimated with Akaike information criterion (AIC) values, an estimation of prediction error (Sakamoto 1986). Models with higher AIC values relative to the null models were determined to be non-predictive. Statistical significance was defined as α = 0.05 (two-tailed). Participants were excluded if they self-reported poor-quality data (Curran 2016), failed two or more attention checks in the social domain assessments, or had poor quality eye-tracking data (repeatedly under 80% of visual fixations captured). All statistical analyses were performed in RStudio 1.3 (The R Foundation for Statistical Computing; Vienna, Austria). The LmerTest R package was used for linear mixed effects modeling (Kuznetsova 2017).

Results

Participant Demographics: Sixty laypersons were included in this study (Table 1), with an average age of 26.2 ± 7.3 years (range: 19 – 59). Participants were mostly women (n = 38, 63.3%) and white (n = 36, 60.0%).

Data Quality and Calibration: Data quality was assessed with the Tobii Pro Lab software package. The average trial length was 9.16 ± 0.56 minutes, including the calibration phase(s). The average percentage of visual fixations captured per trial was 93.6 ± 4.1% (range: 82 – 99%). Participants repeated trials with under 80% of visual fixations captured.

The average calibration accuracy was 0.63 ± 0.81 degrees, 6.08 ± 2.81 mm, and 60.9 ± 78.3 px. The average validation accuracy was 0.53 ± 0.73 degrees, 4.82 ± 5.86 mm, and 48.23 ± 58.71 px. The average validation precision was 0.34 ± 0.47 degrees, 3.19 ± 4.37 mm, and 31.9 ± 43.8 px.

Biases and Social Disposition Results: Sixty participants completed the IAT, with 58 passing the quality assessment. IAT scores ranged from -1.10 to 1.10 (most biased) with an average score of -0.04 ± 0.68 (Table 2). EBQ scores ranged from 2.29 to 5.14 (most biased) with an average score of 3.97 ± 0.65. Results of the social disposition tests are detailed in Table 2.

Visual Fixations: 47,354 visual fixations were captured over 120 trials within defined AOIs. Across all participants and stimuli (pre- and postoperative), nearly half (n = 23,350, 49.3%) of all visual fixations fell within the forehead and orbit, and about one third of fixations (n = 17,031, 36.0%) fell within the nose and lips, with the remainder in the cheek and ear (n = 5,666, 12.0%) and mandible and chin (n = 1,307, 2.8%).

Visual Fixations, Biases, and Social Disposition Analyses: LMEMs evaluated interactions between biases and social disposition scores with pre- and post-operative status to influence visual fixations in AOIs. Participants with higher IAT scores fixated significantly more on the cheek and ear region preoperatively compared to postoperatively ($\beta = 0.115$, SE = 0.040, z = 2.855, $p = 0.004$) (Table 3). IAT scores did not influence participant visual fixations in other AOIs. EBQ scores did not significantly influence visual fixations in any AOIs based on better fit to the null models.

Participants with higher IRI scores in empathic concern and in perspective taking did show differences in their gaze patterns across pre- and post-surgical faces. However, their visual attention did not vary across both conditions for the anomalous portions of the face. Rather, people with higher scores on empathic concern fixated more on the forehead and orbit preoperatively compared to postoperatively ($\beta = -0.107$, SE = 0.053, z = -2.007, $p = 0.045$) and participants with higher IRI scores in perspective taking fixated more on the nose and lips ($\beta = -0.085$, SE = 0.038, z = -2.215, $p = 0.027$) preoperatively compared to postoperatively. Scores on procedural JWBS toward others, distributive JWBS towards others, social dominance orientation, and pathogen disgust did not significantly interact with pre- or postoperative status to influence participant visual fixations.

Discussion

Our faces influence others' perceptions of our social characteristics, including trustworthiness, happiness, and confidence (Mazzaferro 2017), with the "beauty-is-good" stereotype underlying the relationship between attractive faces and positive character trait attributions (Tsukiura 2011). Recent studies have described neural mechanisms underlying a complementary "anomalous-is-bad" bias and implicated specific neuroanatomic structures in the processing of anomalous faces, particularly the amygdala (Workman 2021a). This previous work also quantified relations between levels of implicit bias and social dispositions (i.e., empathic concern) with the strength of these neuroanatomic responses (Workman 2021a). Gaze patterns and visual attention have previously been used to study laypeople's perceptions of craniofacial anomalies. However, visual attention data have not been studied alongside tests evaluating biases or social dispositions and may provide additional insight into the perception of those with facial anomalies. The purpose of this study was to evaluate whether interactions between biases and social characteristics with pre- or postoperative status influence visual attention in laypeople toward those with facial anomalies.

Implicit bias, trait empathic concern, and trait perspective taking interacted with pre- and postoperative status to influence participants' visual fixations. Participants with higher implicit bias scores spent significantly less visual attention on the cheek and ear preoperatively compared to postoperatively. This finding suggests that people with higher levels of implicit bias avoid looking at anomalous anatomy such as the cheek and ear in HFM, although there was no significant difference for the mandible and chin region. Recent work described positive correlations between IAT scores and activation in the bilateral fusiform gyri and left amygdala when viewing anomalous compared to typical faces, and the left amygdala may link facial perception with moral emotions to guide behavior (Workman 2021a), which might account for an implicit avoidance behavior as seen here.

Additionally, participants with elevated dispositional empathic concern were more likely to spend visual attention on the forehead and orbit preoperatively compared to postoperatively, suggesting participants with higher levels of empathy spend more visual attention on non-anomalous anatomy. Previous work demonstrated the degree of amygdala signal change in response anomalous faces was inversely related to levels of empathic concern (Workman 2021a). Participants with higher levels of IRI perspective taking in this study were also significantly more likely to visually fixate on the nose and lips preoperatively. Similar to findings regarding empathic concern, this could suggest participants with higher levels of perspective taking are more likely to visually fixate on normal anatomy. The reasons for this pattern of gaze distribution are not clear. However, unlike those participants with higher IAT scores, they do not avoid looking at anomalous portions of the face. Although empathic concern and perspective taking were not correlated in this study, previous research has demonstrated significant correlations between these facets of dispositional empathy and other inventories assessing trait empathy (Davis 1983, Melchers 2015). This observation could suggest scores in these dispositions function similarly to influence the visual fixation patterns observed in this study.

Implicit biases and trait empathic concern were linked with amygdala responses to anomalous faces as stimuli in a previous study (Workman 2021a). These two psychological variables also interacted to influence visual attention in this study. The amygdala processes visual signals from the anterior visual cortex via a subcortical pathway from the superior colliculus and thalamic nuclei (Brooks 2012). The amygdala, then, could be implicated in modulating visual activity by levels of bias and empathy in response to anomalous faces as visual stimuli (Brooks 2012). Some have suggested that awareness of a negative stimulus is associated with activation of the amygdala to increase activity in the fusiform gyrus, and that this mechanism exists to ensure important visual stimuli achieve awareness (Duncan 2007).

We acknowledge several limitations in this study. This study used eye-tracking technology with the presentation of stimuli in two-dimensions. Thus, several anatomic features including jaw projection and lateral mandibular structure may be difficult to discern and the images may not representative of three-dimensional human anatomy. This study also presents visual stimuli at fixed distances from the participant, which cannot account for dynamic interactions at different physical distances, as in social settings. Additionally, several recent critiques of the IAT suggest the associations it examines are fragile and may not correlate with real world behaviors. Although potentially flawed, the existence of implicit bias is difficult to deny (Jost 2009).

Despite these limitations, this study characterized relations between biases and social dispositions with visual attention toward people with facial anomalies and characterized the way biases and social dispositions influence visual attention when looking at faces with anomalous anatomy.

Conclusions

Levels of biases, empathic concern, and other social dispositions may influence visual attention toward people with facial anomalies. Those with higher levels of implicit bias may visually avoid looking at anomalous anatomy, while those with higher levels of empathic concern and perspective taking do not show similar avoidance behaviors. These findings may have neural underpinnings with amygdala response modulating visual activity in response to facial anomalies. This study has implications for the experience of patients with craniofacial anomalies and for characterizing neurologic mechanisms of the "beauty-is-good" and "anomalous-is-bad" biases.

Acknowledgements: This research was funded by the Penn Center for Human Appearance (to JAT and AC), the Division of Plastic & Reconstructive Surgery at the Children's Hospital of Philadelphia and the Perelman School of Medicine at the University of Pennsylvania, and the National Institute of Dental & Craniofacial Research of the National Institutes of Health (F32DE029407 to CIW). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

References

Alpers, G. W. (2008). Eye-catching: Right hemisphere attentional bias for emotional pictures. *Laterality*, *13*(2), 158-178.

Alpers, G. W., & Gerdes, A. (2007). Here is looking at you: emotional faces predominate in binocular rivalry. *Emotion*, *7*(3), 495.

Asaad, M., Dey, J. K., Al-Mouakeh, A., Manjouna, M. B., Nashed, M. A., Rajesh, A., ... & Bite, U. (2020). Eye-tracking technology in plastic and reconstructive surgery: a systematic review. *Aesthetic surgery journal*, *40*(9), 1022-1034.

Brooks, S. J., Savov, V., Allzén, E., Benedict, C., Fredriksson, R., & Schiöth, H. B. (2012). Exposure to subliminal arousing stimuli induces robust activation in the amygdala, hippocampus, anterior cingulate, insular cortex and primary visual cortex: a systematic meta-analysis of fMRI studies. *NeuroImage*, *59*(3), 2962-2973.

Curran, P. G. (2016). Methods for the detection of carelessly invalid responses in survey data. *Journal of Experimental Social Psychology*, *66*, 4-19.

Dang, T. N., & Wilkinson, L. (2014). Transforming scagnostics to reveal hidden features. *IEEE transactions on visualization and computer graphics*, *20*(12), 1624-1632.

Davis, M. H. (1980). A multidimensional approach to individual differences in empathy. JSAS Catalog of Selected Documents in Psychology, 10, 85.

Davis, M. H. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. *Journal of personality and social psychology*, *44*(1), 113.

Dion, K., Berscheid, E., & Walster, E. (1972). What is beautiful is good. *Journal of personality and social psychology*, *24*(3), 285.

Eagly, A. H., Ashmore, R. D., Makhijani, M. G., & Longo, L. C. (1991). What is beautiful is good, but…: A meta-analytic review of research on the physical attractiveness stereotype. *Psychological bulletin*, *110*(1), 109.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior research methods*, *39*(2), 175-191.

Glashouwer, K. A., Smulders, F. T., de Jong, P. J., Roefs, A., & Wiers, R. W. (2013). Measuring automatic associations: Validation of algorithms for the Implicit Association Test (IAT) in a laboratory setting. *Journal of Behavior Therapy and Experimental Psychiatry*, *44*(1), 105-113.

Greenwald, A. G., & Krieger, L. H. (2006). Implicit bias: Scientific foundations. *California law review*, *94*(4), 945-967.

Greenwald, A. G., Nosek, B. A., & Banaji, M. R. (2003). Understanding and using the implicit association test: I. An improved scoring algorithm. *Journal of personality and social psychology*, *85*(2), 197.

Hartung, F., Jamrozik, A., Rosen, M. E., Aguirre, G., Sarwer, D. B., & Chatterjee, A. (2019). Behavioural and neural responses to facial disfigurement. *Scientific reports*, *9*(1), 1-10

Haworth, R., Sobey, S., Chorney, J. M., Bezuhly, M., & Hong, P. (2015). Measuring attentional bias in children with prominent ears: a prospective eye-tracking study. *Journal of Plastic, Reconstructive & Aesthetic Surgery*, *68*(12), 1662-1666.

Jamrozik, A., Oraa Ali, M., Sarwer, D. B., & Chatterjee, A. (2019). More than skin deep: Judgments of individuals with facial disfigurement. *Psychology of Aesthetics, Creativity, and the Arts*, *13*(1), 117.

Jost, J. T., Rudman, L. A., Blair, I. V., Carney, D. R., Dasgupta, N., Glaser, J., & Hardin, C. D. (2009). The existence of implicit bias is beyond reasonable doubt: A refutation of ideological and methodological objections and executive summary of ten studies that no manager should ignore. *Research in organizational behavior*, *29*, 39-69.

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. (2017). lmerTest package: tests in linear mixed effects models. *Journal of statistical software*, *82*(1), 1-26.

Lim, K. K., Friedrich, M., Radun, J., & Jokinen, K. (2013, December). Lying through the eyes: detecting lies through eye movements. In *Proceedings of the 6th workshop on Eye gaze in intelligent human machine interaction: gaze in multimodal interaction* (pp. 51-56).

Lucas, T., Zhdanova, L., & Alexander, S. (2011). Procedural and Distributive Justice Beliefs for Self and Others Assessment of a Four-Factor Individual Differences Model. *Journal of Individual Differences, 32*(1), 14-25.

Mazzaferro, D. M., Wes, A. M., Naran, S., Pearl, R., Bartlett, S. P., & Taylor, J. A. (2017). Orthognathic surgery has a significant effect on perceived personality traits and emotional expressions. *Plastic and reconstructive surgery*, *140*(5), 971-981.

Melchers, M., Li, M., Chen, Y., Zhang, W., & Montag, C. (2015). Low empathy is associated with problematic use of the Internet: Empirical evidence from China and Germany. *Asian journal of psychiatry*, *17*, 56-60.

Meyer-Marcotty, P., Alpers, G. W., Gerdes, A., & Stellzig-Eisenhauer, A. (2010). How others perceive orthognathic patients: an eye-tracking study. *World journal of orthodontics*, *11*(2).

Meyer-Marcotty, P., Gerdes, A. B. M., Reuther, T., Stellzig-Eisenhauer, A., & Alpers, G. W. (2010). Persons with cleft lip and palate are looked at differently. *Journal of dental research*, *89*(4), 400-404.

Meyer-Marcotty, P., Gerdes, A. B., Stellzig-Eisenhauer, A., & Alpers, G. W. (2011). Visual face perception of adults with unilateral cleft lip and palate in comparison to controls—an eye-tracking study. *The Cleft palate-craniofacial journal*, *48*(2), 210-216.

Quast, A., Waschkau, J., Saptschak, J., Daratsianos, N., Jordan, K., Fromberger, P., ... & Meyer-Marcotty, P. (2018). Facial perception of infants with cleft lip and palate with/without the NAM appliance. *Journal of Orofacial Orthopedics/Fortschritte der Kieferorthopädie*, *79*(6), 380-388.

Sakamoto, Y., Ishiguro, M., & Kitagawa, G. (1986). Akaike information criterion statistics. *Dordrecht, The Netherlands: D. Reidel*, *81*(10.5555), 26853.

Sidanius, J., & Pratto, F. (2001). *Social dominance: An intergroup theory of social hierarchy and oppression*. Cambridge University Press.

Tsukiura, T., & Cabeza, R. (2011). Shared brain activity for aesthetic and moral judgments: implications for the Beauty-is-Good stereotype. *Social cognitive and affective neuroscience*, *6*(1), 138-148.

Tybur, J. (2009). Dissecting disgust: an investigation of the validity of the Three Domain Disgust Scale.

Warne, C. N., Hallac, R. R., Kane, A. A., Derderian, C. A., & Seaward, J. R. (2019). Eye tracking as a proxy for perceptual evaluation of repaired cleft lip. *Journal of Craniofacial Surgery*, *30*(2), 395-399.

Workman, C. I., Humphries, S. A., Hartung, F., Aguirre, G. K., Kable, J. W., & Chatterjee, A. (2021). Morality is in the eye of the beholder: the neurocognitive basis of the “anomalous-is-bad” stereotype. *Annals of the New York Academy of Sciences*.

Workman, C. I., & Chatterjee, A. (2021). The Face Image Meta-Database (fIMDb) & ChatLab Facial Anomaly Database (CFAD): tools for research on face perception and social stigma. *Methods in Psychology*, *5*, 100063.

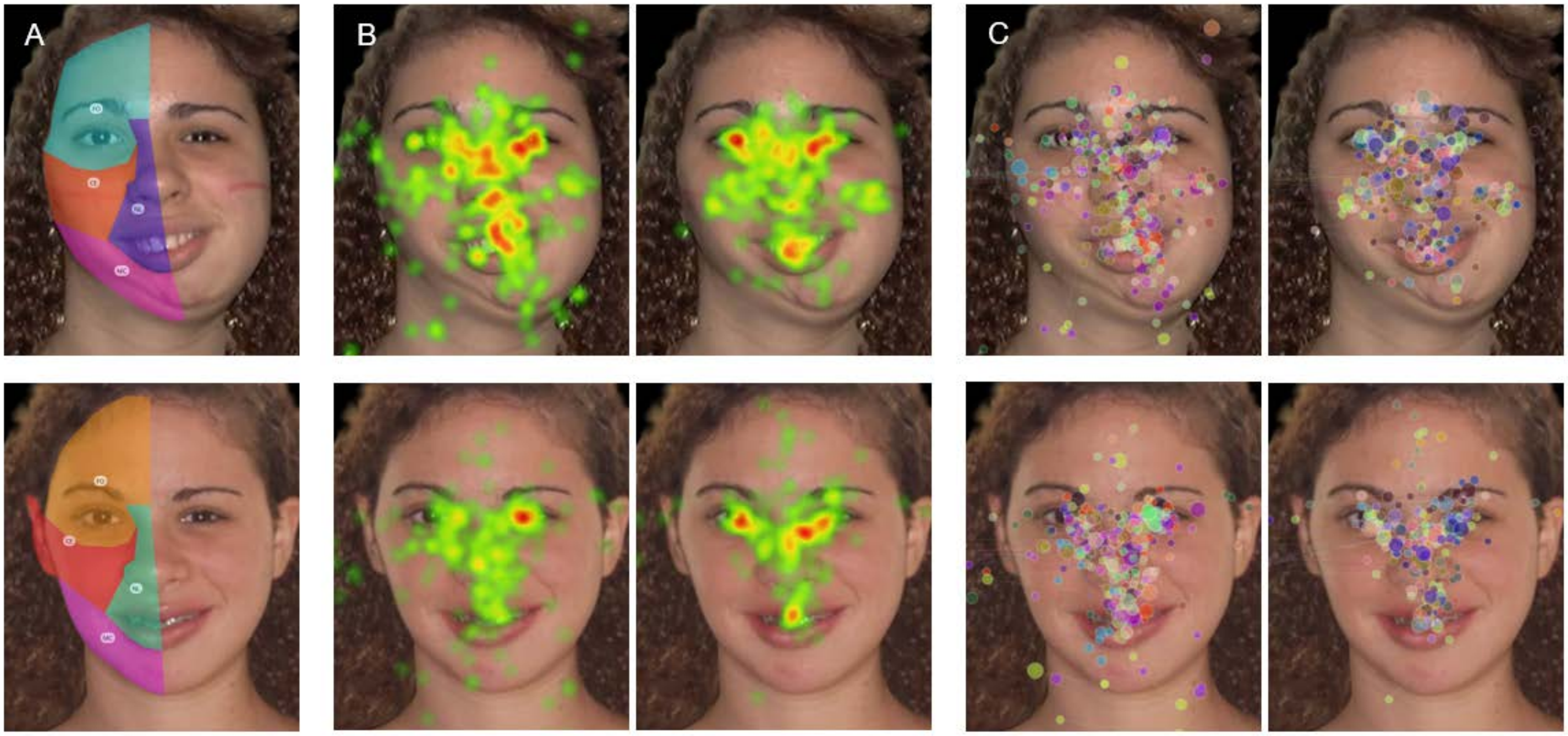

Figure 1. Example stimuli preoperative (top) and postoperative (bottom) with A) demarcated areas of interest (AOIs); B) heat maps for number of visual fixations; and C) duration of visual fixations for ten participants with highest (left) and lowest (right) implicit bias scores.

Table 1. Participant Demographics

	N (%)
Total Participants	60
Sex assigned at birth	
Female	38 (63.3)
Male	22 (36.7)
Gender identity	
Female	34 (56.7)
Male	23 (38.3)
Trans/gender nonconforming	3 (5.0)
Race*	
White	36
Asian	25
Black/African American	11
American Indian	0
Other	1
Prefer not to answer	2
Ethnicity	
Not Hispanic or Latino	54 (90.0)
Hispanic or Latino	6 (10.0)
Sexuality	
Heterosexual	37 (61.7)
Bisexual	9 (15.0)
Lesbian, gay, or homosexual	6 (10.0)
Queer	3 (5.0)
Asexual	2 (3.3)
Pansexual	1 (1.7)
Prefer not to answer	2 (3.3)
Handedness	
Right	54 (90.0)
Left	6 (10.0)
Average Age (SD)	26.2 (7.3)
Average years of education (SD)	16.6 (2.6)

*Participants may select more than one race

Table 2. Tests of Biases and Social Dispositions

Implicit Bias	-0.04 ± 0.68
Explicit Bias Total	3.97 ± 0.65
Is disabled	7 (11.7)
Has facial anomaly	0 (0)
Disabled family member	21 (35.0)
Family facial anomaly	11 (18.3)
Social Dominance Orientation	3.91 ± 0.46
JWBS: Distributive Others	3.15 ± 1.46
JWBS: Procedural Others	3.11 ± 1.29
IRI: Empathic Concern	3.25 ± 0.28
IRI: Perspective Taking	3.37 ± 0.45
TDDS: Moral	32.78 ± 6.66
TDDS: Sexual	23.78 ± 8.47
TDDS: Pathogen	31.08 ± 6.88

Values reported in mean ± SD or n (%). JWBS: Just World Beliefs Scale; IRI: Interpersonal Reactivity Index; TDDS: Three Domains of Disgust Scale

Table 3. Interactions of Biases or Social Dispositions with Visual Fixations by Area of Interest

Fixed Effects	β	SE	Z-value	*p*
Implicit Bias Association Test				
Forehead and Orbit	0.015	0.023	0.627	0.531
Cheek and Ear	0.115	0.040	2.855	0.004**
Nose and Lips	-0.005	0.025	-0.203	0.839
Mandible and Chin	-0.066	0.079	-0.837	0.402
Explicit Bias Questionnaire				
Forehead and Orbit	0.000	0.001	-0.137	0.891
Cheek and Ear	-0.001	0.002	-0.336	0.737
Nose and Lips	0.000	0.001	-0.142	0.887
Mandible and Chin	0.002	0.004	0.512	0.609
Interpersonal Reactivity Index: Empathic Concern				
Forehead and Orbit	-0.107	0.053	-2.070	0.045*
Cheek and Ear	0.132	0.102	1.291	0.197
Nose and Lips	-0.017	0.060	-0.289	0.772
Mandible and Chin	0.168	0.203	0.829	0.407
Interpersonal Reactivity Index: Perspective Taking				
Forehead and Orbit	-0.009	0.034	-0.256	0.798
Cheek and Ear	0.001	0.059	0.011	0.991
Nose and Lips	-0.085	0.038	-2.215	0.027*
Mandible and Chin	0.159	0.124	1.294	0.196
Just World Belief Scale: Procedural				
Forehead and Orbit	-0.007	0.012	-0.602	0.547
Cheek and Ear	0.003	0.020	0.126	0.900
Nose and Lips	-0.019	0.013	-1.400	0.161
Mandible and Chin	0.025	0.041	0.606	0.544
Just World Belief Scale: Distributive				
Forehead and Orbit	0.006	0.01	0.545	0.586
Cheek and Ear	-0.014	0.019	-0.712	0.477
Nose and Lips	-0.008	0.012	-0.741	0.459
Mandible and Chin	0.034	0.037	0.936	0.349
Social Dominance Orientation				
Forehead and Orbit	-0.003	0.032	-0.100	0.920
Cheek and Ear	-0.077	0.060	-1.274	0.203
Nose and Lips	0.013	0.035	0.377	0.706
Mandible and Chin	0.160	0.136	1.173	0.241
Three Domains of Disgust: Pathogen				
Forehead and Orbit	0.004	0.002	1.722	0.085
Cheek and Ear	-0.001	0.004	-0.353	0.724
Nose and Lips	-0.002	0.002	-0.924	0.356
Mandible and Chin	-0.007	0.009	-0.760	0.447

Table S1. The Explicit Bias Questionnaire (EBQ)

#	Question	Options	
1	How often have you encountered or do you interact with a person with a facial disfigurement (marks, rashes, scars, asymmetry, paralysis, etc.)?	Yes	No
2	Do you have a disability?	Yes	No
3	Do you have a facial disfigurement?	Yes	No
4	Do you have a close friend or family member with a disability?	Yes	No
5	Do you have a close friend or family member with a facial disfigurement?	Yes	No
6	How important is your physical appearance on a scale from 1 to 7?	1 = Extremely unimportant	7 = Extremely important
7	How warm or cold do you feel towards people with facial disfigurement? (RS)	1 = Extremely cold	7 = Extremely warm
8	Which statement best describes you? (RS)		
	1 = I strongly prefer people without facial disfigurements t people with facial disfigurements		
9	They are more happy, confident, assured, and cheerful than others. (RS)	1 = Strongly disagree	7 = Strongly agree
10	They are more sad, shy, and miserable than others.	1 = Strongly disagree	7 = Strongly agree
11	They are more attractive, desirable, and eligible than others. (RS)	1 = Strongly disagree	7 = Strongly agree
12	They are more unattractive, undesirable, ugly, and unsuitable than others.	1 = Strongly disagree	7 = Strongly agree
13	They are more easy-going, approachable, likeable, and friendly than others. (RS)	1 = Strongly disagree	7 = Strongly agree
14	They are more awkward, unlikeable, unapproachable, and unfriendly than others.	1 = Strongly disagree	7 = Strongly agree
15	They are more successful, motivated, accomplished, and more likely to succeed than others. (RS)	1 = Strongly disagree	7 = Strongly agree
16	They are more limited and unmotivated and more likely to fail than others.	1 = Strongly disagree	7 = Strongly agree
17	Sad to happy	1 = Sad	7 = Happy
18	Unconfident to confident	1 = Unconfident	7 = Confident
19	Incompetent to competent	1 = Incompetent	7 = Competent
20	Shy to assured	1 = Shy	7 = Assured
21	Miserable to cheerful	1 = Miserable	7 = Cheerful
22	Unattractive to attractive	1 = Unattractive	7 = Attractive
23	Undesirable to desirable	1 = Undesirable	7 = Desirable
24	Ugly to gorgeous	1 = Ugly	7 = Gorgeous
25	Stupid to intelligent	1 = Stupid	7 = Intelligent
26	Unsuitable to eligible	1 = Unsuitable	7 = Eligible

27	Awkward to easy-going	1 = Awkward	7 = Easy-going
28	Untrustworthy to trustworthy	1 = Untrustworthy	7 = Trustworthy
29	Unapproachable to approachable	1 = Unapproachable	7 = Approachable
30	Unfriendly to friendly	1 = Unfriendly	7 = Friendly
31	Non-achiever to achiever	1 = Non-achiever	7 = Achiever
32	Ordinary to accomplished	1 = Ordinary	7 = Accomplished
33	Unmotivated to motivated	1 = Unmotivated	7 = Motivated

RS = Reverse Scored