Commentary

Commentary on: A Crowdsourced Evaluation of Facial Averageness and Attractiveness

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Crowdsourced evaluation of facial averageness and attractiveness[1] is a recently introduced online method in the field of aesthetic plastic surgery.[2,3] The authors employed this method to verify whether composite-averaged faces are perceived as the most attractive. Their ultimate goal is to use composite images as a framework to compare postoperative results. Although beauty has long been considered highly subjective, our preferences and decision-making processes are neural processes that fall within the realm of scientific investigation.[4–6] The authors' conclusions accord with the well-accepted neuroscience finding that a composite face is preferred over the individual faces from which the composite is generated. This holds true regardless of gender, age, or geographic background.[7]

THE NECESSITY OF MODELS FOR EACH ETHNIC GROUP

The authors acknowledge they were not able to investigate the aesthetic ideals of various ethnic groups because their composite consisted only of Caucasians. The goal is not to establish strict measures by which beauty is defined, as proponents of the golden proportion propose. Beauty is too vast to be contained in a number or a mathematical formula. The objective is to establish references for each ethnic group with a sufficiently wide margin that encompasses the plurality of the nature of beauty.

BEAUTY AND HEALTH STATUS: NO SURVIVAL OF THE PRETTIEST

The authors suggest a link between facial appearance and health status. Although the authors reference Rhodes et al, the article does not support this conclusion. Rhodes et al state that "the most comprehensive study, using lifetime health data for a large group of participants, failed to find any link between attractiveness and physical health."[8] The difference between "appearing" and "being" healthy should be emphasized (Figure 1). The scientific community should be careful in making assertions concerning a link between beauty and health: it would only be a short step from there to declare that "to be in good health one must be beautiful, and that cosmetic surgery can indirectly improve physical health." This false claim could be easily leveraged by unethical physicians or other entities to manipulate patients and individuals for the sake of financial gain or progress toward the concept of a "master race."

LGBTQ+ PEOPLE VOICE PREFERENCE LESS STRONGLY THAN THE HETEROSEXUAL POPULATION

The authors report that nonbinary voters preferred the composite the least strongly. They theorize that LGBTQ+ populations are more likely to live in LGBTQ+ neighborhoods, citing Rhodes et al as a reference. However, Rhodes et al were cautious in their conclusion, stating that renormalizing the face-space to acquire expertise with a new population of faces may be short-lived. The

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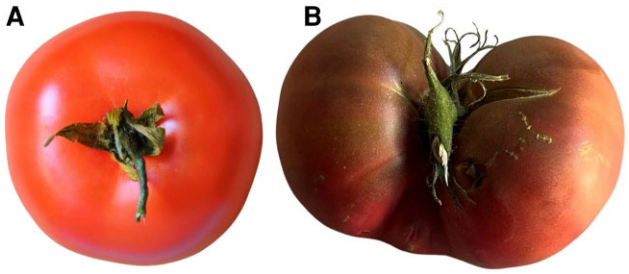

Figure 1. (A) Close-up photograph of a prototype of a tomato referring to the central statistical tendency of tomato configuration. Photograph by Miguel Á. Padriñán from Canva (https://www.canva.com/photos/MADGxqVyLhE-close-up-photography-of-a-tomato/). (B) "Ugly tomato," Vaison la Romaine. Photograph by Fahd Benslimane. Photograph of a tomato the appearance of which departs from the central tendency. This tomato deviates from our perception of beauty but its appearance does not predict its nutritional value. Both tomatoes have the same nutritional value.

inhabitants of LGBTQ+ neighborhoods are not only exposed to the category of LGBTQ+ prototypes. The presence of "typical models" of heterosexual populations is pervasive throughout the public domain if only through social media.

FINDINGS FROM DECADES OF RESEARCH IN NEUROSCIENCE

It is of the utmost importance to recall the advances in neuroscience in order to understand the mechanisms of visual perception and facial recognition that underly visual preferences. Considerable evidence from 4 decades of neuroscience research already demonstrates that adults and even newborn infants can cognitively average across a set of faces to form a mental composite face that seems familiar. This composite image is called a "prototype" and is found to be perceived as more attractive than the set of faces from which the prototype is extracted (Figure 2).[9–11] Familiarity with the prototype is termed "typicality" and is considered as a pivotal component of facial recognition.[12] These concepts became difficult for scientists to apply and to understand how stimuli are extracted from real images of faces to allow recognition and categorization of real faces.[13] Valentine's face-space concept[14] offered a more comprehensive model of a multidimensional psychological space where the composite face retains a special status because it is extracted from all faces previously seen and serves as a standard by which each new face encountered is evaluated.[15] In this same line of research, there is strong evidence from neurophysiological studies and research in psychophysics perception of neural processes demonstrating that "to perceive" essentially means "to reconstruct from comparing" (Professor Wolf Singer, personal communication, July 2020). Simply put, our brain contains a vast database

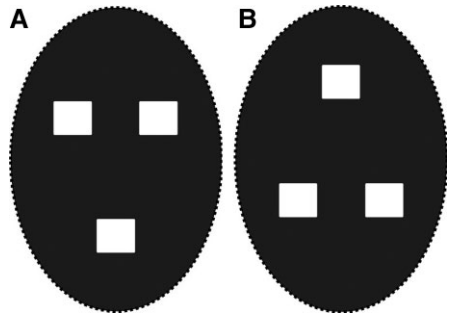

Figure 2. Nine minutes after birth, human newborns prefer looking at highly schematized face-like configurations (A) rather than at other, equally complex, visual stimuli (B) with internal features that are far from the central tendency.

of all categories of faces compiled from all of the faces that we have seen during our lives. For each newly encountered face, our brain compares it to the composite face in our mental database. At first, a rough match between the sensory signals and the prototype available to our brain generates a percept, not perception perception of reality. Through a process of repetition, our brain filters the obtained approximations by making them converge towards an optimal solution according to race, gender, age, physical fitness, etc, until reaching a form of adequacy which presents a minimum of unresolved ambiguities with the typical face of this category in the database.[16] As an example, we can all approximate a person's age from our previously compiled internal image database. This mechanism of visual perception involves top-down processing and is considered an essential feature of human cognition.[17] It accelerates visual processing by imparting our knowledge a priori onto what we see in order to ascribe meaning to a perceived image in a 100-millisecond exposure to a face (Figure 3).[18] The closer the face is to the prototype, the less energy our brain needs to expend to interpret it because the information is already rooted in its architecture.[19] In many ways, determining beauty seems to be energy efficient for the brain as prototypes seem to be easier and faster to read than are faces that fall outside of our central prototype.

DO WE NEED ANTHROPOMETRIC MEASUREMENTS?

I applaud the authors for not approaching the subject from the esoteric angle of a mathematical formula. As stated by Harari in his seminal book *Sapiens*, our brain has been adapted to process only particular types of information such as shapes, not numbers.[20] Thus, shape analysis forms the very basis of facial and object recognition. To the best of my knowledge, Sheen and Sheen were the first to fully develop this line of thinking in plastic surgery. They developed their aesthetic reasoning on nasal curve analysis based on light reflex and

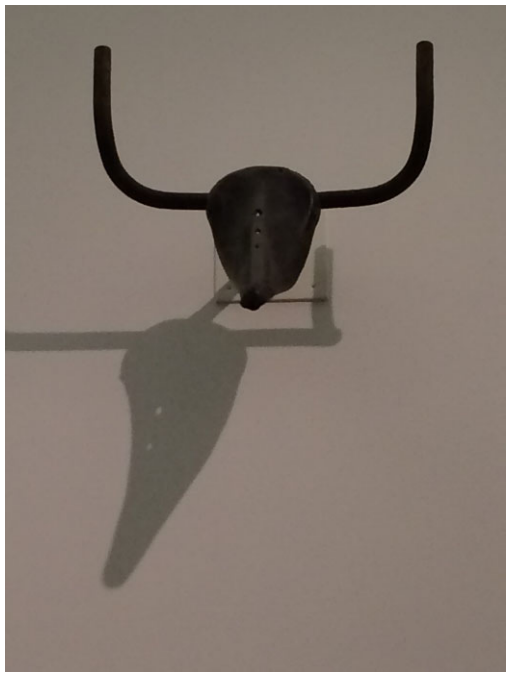

Figure 3. *Bull's Head*, Pablo Picasso, Musée National Picasso-Paris. Photograph by Fahd Benslimane. The representation of a bull's head is striking. However, from the moment we know that Picasso created this sculpture from the assemblage of a seat and handlebars of a bicycle, this information will be imparted to the image each time we see it thanks to our top-down processing mechanism. The bull's head, along with the bicycle's seat and handlebars, will be in the front of the mind exactly as the artist wished his sculpture to be perceived.

shadow rather than relying on a formula for beauty evaluation they described as "so transcendental that it can't be used."[21]

QUEST FOR UNDERSTANDING BEAUTY: A HOLISTIC APPROACH

Functional Beauty

What if beauty were strictly linked to functionality? That is to say, that curves with a certain arch form would more efficiently transport nutrients with minimum resistance, resulting in minimum energy expenditure? The structural development of the face has taken place under specific evolutionary principles of biological growth that are not arbitrary.[22,23] Facial growth stems from vascular axes that follow a certain trajectory, resulting in curves with arch forms that may be optimal for physical expansion.[24] This arch form is ubiquitous in nature, as are the tree-like branching networks found in river systems and in bronchial and cardiovascular systems.[22] Arch forms iterate themselves on faces as they do on bodies and elsewhere in nature.[24] According to Pessa and Chen, "The perception of attractivity may be guided by the perception of iterative shapes

Figure 4. The fundamental sclera/iris contrast does not exist at the level of the eye fissure of macaques as white sclera is an exception in primates. The eye fissure presents an almost round aspect. According to the cooperative eye hypothesis, the horizontal elongation of the eye fissure in humans allowed more scleral show laterally and medially in relation to the iris, hence an even greater contrast between the eyes and the face. Additional noise represented by hollows around the eye fissure and multiple lines in a chaotic fashion distracts the attention of the viewer from focusing on the eyes of the primate. Image courtesy of Pixabay. (https://www.pixabay.com).

of the facial features."[23] In many ways, the perception of facial beauty seems to arise from the interaction between facial curves that iterate themselves in a certain pattern following the least resistant path for expansion, and the human brain capable of both reading and anticipating a recurrence of very specific curves. This information is deeply rooted in the brain and thus reduces neural activity and energy expenditure.

Lessons Learned From Anthropology

We learn from anthropology how our appearance has diverged from that of our ancestors under evolutionary pressure. For example, the cooperative eye hypothesis suggests that the human eye, with its unique overriding contrast between the colored iris and the white scleral triangles, evolved to make it easier for humans to follow another's gaze while communicating.[25] The horizontal elongation of the eye fissure allowed more lateral and medial scleral show, rendering the eye even more noticeable (Figure 4).[26] Additional visual noise was reduced, allowing the eye to present an even greater contrast with the face: the skull evolved into a more convex shape and soft tissues filled in the remaining hollows, resulting in a convex, and hence more light reflective, face. A direct application in periorbital rejuvenation and beauty enhancement is the reduction of shadows around the eye fissure by frame narrowing.[27]

Lessons Learned From Visual Arts: Every Attractive Face Presents The Basic Identifying Landmarks

Pictorial arts allow a better understanding of the simplest visual expression present on every attractive youthful

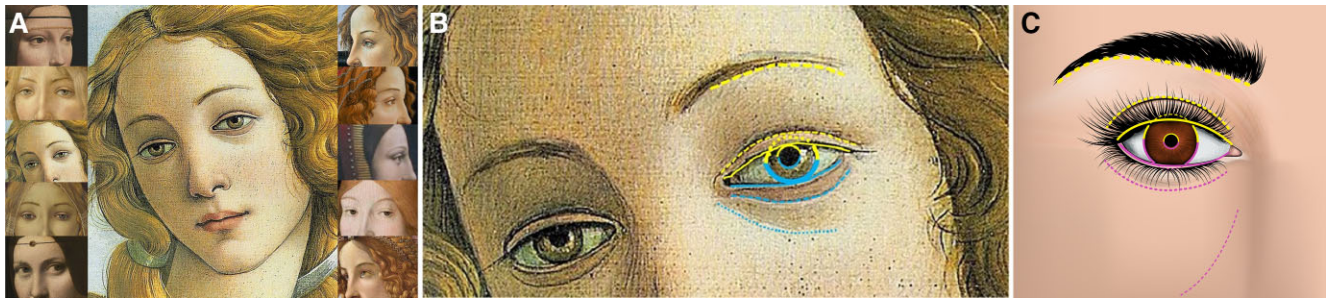

Figure 5. (A) Photograph of a collage of 10 paintings of historically beautiful women portrayed during the Renaissance. They display a patterned recurrence of the basic identifying landmarks represented by a set of fundamental contrasts. (1) *Lady with an Ermine*, Leonardo da Vinci, reproduced from: https://commons.wikimedia.org/wiki/File:Dama_z_gronostajem.jpg. This work is in the public domain. (2) *La Primavera*, Sandro Botticelli, reproduced from: https://commons.wikimedia.org/wiki/File:Primavera_(Botticelli).jpg, licensed under Creative Commons Attribution-Share Alike 4.0 International. (3) *Del Nacimiento de Venus*, Sandro Botticelli, https://commons.wikimedia.org/wiki/File:Detalles_del_Nacimiento_de_Venus,_Botticelli,_Florencia,_Italia,_2019_01.jpg, licensed under Creative Commons Attribution-Share Alike 4.0 International. (4) *Madonna of the Pomegranate*, Sandro Botticelli, Reproduced from: https://commons.wikimedia.org/wiki/File:Gallerie_des_Offices_Florence_(29120983832).jpg, licensed under Creative Commons Attribution 2.0 Generic. (5) *La Belle Ferronnière*, Leonardo da Vinci, reproduced from: https://commons.wikimedia.org/wiki/File:La_belle_ferronni%C3%A8re,Leonardo_da_Vinci_-_Louvre.jpg, licensed under Creative Commons Attribution-Share Alike 4.0 International. (6) *Idealized Portrait of a Lady (Portrait of Simonetta Vespucci as Nymph)*, Sandro Botticelli, reproduced from: https://commons.wikimedia.org/wiki/File:Sandro_Botticelli__Idealized_Portrait_of_a_Lady_(Portrait_of_Simonetta_Vespucci_as_Nymph)_-_Google_Art_Project.jpg, this work is in the public domain. (7) *Simonetta Vespuci as a Nymph*, Sandro Botticelli, reproduced from: https://commons.wikimedia.org/wiki/File:Simonetta_Vespuci_as_a_Nymph_by_Sandro_Botticelli_-_Städel_-_Frankfurt_am_Main_-_Germany_2017.jpg, licensed under Creative Commons Attribution-Share Alike 4.0 International. (8) *La Belle Ferronnière*, Leonardo da Vinci, reproduced from: https://commons.wikimedia.org/wiki/File:Scuola_di_leonardo_da_vinci,_la_belle_ferroni%C3%A8re,_XVI_sec.jpg, licensed under Creative Commons Attribution 3.0 Unported. (9) *Portrait of a Woman with a Pearl Necklace*, Lorenzo Costa, reproduced from: https://commons.wikimedia.org/wiki/File:Lorenzo_Costa_-_Portrait_of_a_Woman_with_a_Pearl_Necklace_-_WGA5433.jpg, this work is in the public domain. (10) *Simonetta Vespucci as Maria Lactans*, Sandro Botticelli, reproduced from: https://commons.wikimedia.org/wiki/File:Botticelli_-Simonetta_Vespucci_as_Maria_Lactans.jpg, licensed under Creative Commons Attribution-Share Alike 4.0 International. (B) Photograph of the periorbital region of the Venus of Botticelli. The basic identifying landmarks are represented in yellow for the upper hemisphere and sky blue for the lower hemisphere. *La Primavera*, Sandro Botticelli, reproduced from: https://commons.wikimedia.org/wiki/File:Primavera_(Botticelli).jpg, licensed under Creative Commons Attribution-Share Alike 4.0 International. (C) At the periorbital area, for example, the patterned recurrence of the basic identifying landmarks are represented in yellow for upper hemisphere, purple for the lower hemisphere.

face. This can be illustrated with the basic identifying landmarks (BILs) represented by a set of fundamental contrasts (SFCs) which are present on the vast majority of historically beautiful women's faces portrayed in art (Figure 5). It is remarkable that the BILs are displayed with a patterned recurrence which is the very definition of a rhythm. It is all the more remarkable that artists and plastic surgeons have always recognized the importance of the most important of all iterations: symmetry, which is simply an iteration with respect to the sagittal plane. An example of patterned recurrence of the BILs is easily identified at the periorbital area. It starts at the center of the eye with the most accentuated curves, ie, the small/dark pupillary disc, followed by the colored diaphragm of the iris; the latter creates the most fundamental contrast on the human face: the iris-sclera contrast. There follow iterations of curves which gradually open up: the two horizontally elongated curves of the upper and lower eyelid margins, one seeming to mirror the other. Each curve tends to repeat the curve of the corresponding marginal arterial arcade. At the periphery, the upper palpebral fold is typically well-defined and located low, close to the eyelashes. It is parallel to the free palpebral edge that it seems to iterate. It delimits a short and horizontally elongated pretarsal segment. The lower palpebral fold is typically less defined than the upper one. It delimits a short and horizontally elongated pretarsal segment that appears to mirror its upper counterpart. Beyond the palpebral folds, the eyelid surface is convex and light reflective without discontinuity until the eyebrow superiorly, flat or slightly concave until a smooth lid-cheek interface inferiorly. The tear trough is present although its outline is only mildly visible. These concepts apply to much of humanity but there are variations when broadly applying them to different races such as to some Asian populations. My awareness of the rhythm of iteration of BILs was further heightened by superimposing BIL composites on patients' images to evaluate the deviations from the prototype. For example, the frame concept[27] based on contrasts has

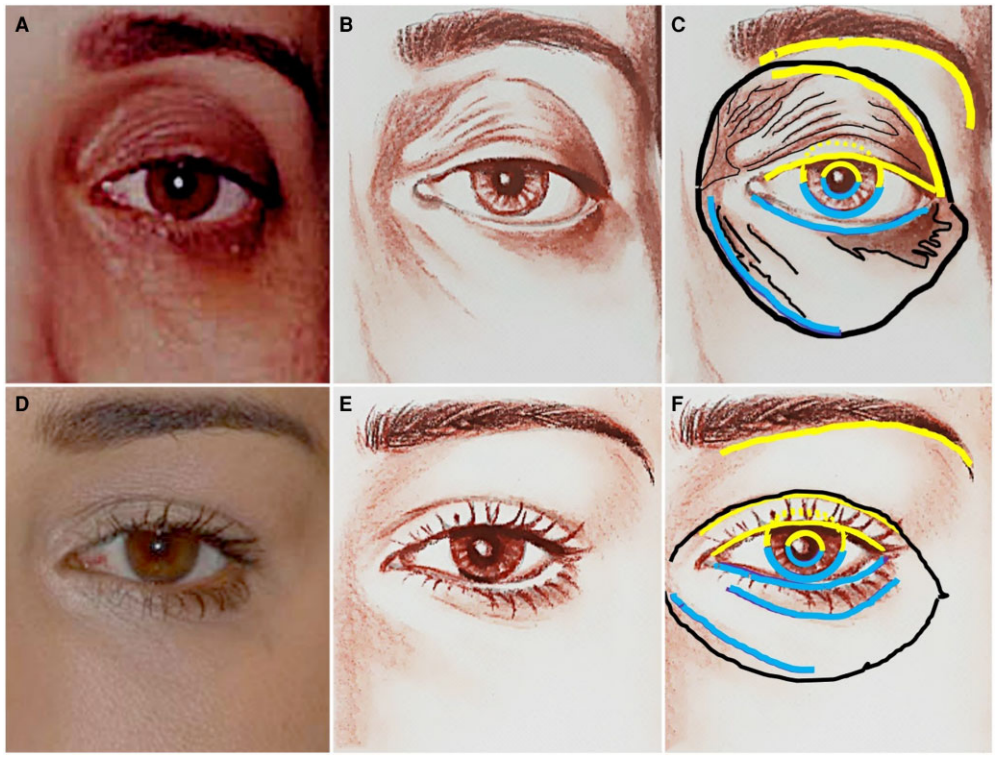

Figure 6. (A) Photograph of the preoperative condition of the left periorbital region of a 39-year-old female patient. (B) A drawing of the photograph of the same patient: pictorial arts allow better visualization of contrasts that our brain analyses by its edge detection mechanism. (C) Marking of multiple luminance and chromatic contrasts which create 3 types of visual noises. (1) A wide frame of shadows illustrated with the thick black outline. (2) Both upper and lower segments of the frame of shadows depart from the patterned recurrence that ideally follows gradually the curvatures of the corresponding hemicircles of the pupil, the iris and the margin of the eyelids (represented in yellow for the upper hemisphere, and in sky blue for the lower hemisphere.) (3) Multiple random unorganized contrasts located within the frame illustrated by the fine black lines on the upper and lower eyelids. (D) Photograph of the postoperative condition of the left periorbital region of the same patient. (E) A drawing of the postoperative photograph of the same patient: the reduction in visual noise is obvious. Contrasts are oriented in a more rhythmic fashion, allowing an easier reading of the periorbital region. (F) Marking of the new contrast condition. (1) The frame of shadows was narrowed. (2) More importantly, its upper and lower segments were reoriented following the patterned recurrences of the corresponding curvatures from pupil to eyelid margin. (3) Contrasts within the frame were completely effaced on the upper eyelid and significantly reduced on the lower one.

proven useful provided it is specified that, in addition to being narrow, the ideal frame exhibits a patterned recurrence seemingly parallel to the margin of the eyelids, thus iterating their smooth, horizontally elongated shape (Figure 6).

Lessons Learned From Cognitive Sciences: Every Prototype Presents The Basic Identifying Landmarks

We learn from neuroscience that edge detection is a fundamental first step in facial recognition as it reveals the core information of any image: contours.[28,29] It is precisely this mechanism of edge detection which reveals to our brain the SFCs, hence defining the BILs. It is remarkable that the BILs found in pictorial art are present and arranged in the same patterned recurrence on every averaged composite face I examined including the 2 male and female composites represented in Amaya et al's Figures 1 and 2.[1,3,15,30–35] This holds particularly true for the most important area of facial attractiveness: the eye region.[36]

A direct application would be:

1. To superimpose the composit BIL on each corresponding area of a given patient in order to understand the gap between the BIL and the patient's configuration.
2. To define which are the major deviations that contribute the most to an unsightly or aging appearance to prioritize these deviances.
3. To define the appropriate procedures to recreate the edge contrasts that most resemble the rhythm of the BILs.
4. To assess postoperatively the result by comparing the outcome to the BILs.

An additional level of complexity was introduced by Perrett et al, who demonstrated that facial composites of the best-looking women are more attractive than composites of the broader group of women of which the best-looking women are a subset.[30] One should be cautious about utilizing these "supercomposites" because when care is not taken to develop composites from a population of the same ethnic group, a clear presence of dominant African features in the bottom 10% of attractiveness is noticeable, whereas a composite-averaged face generated from faces in the top 10% of attractiveness displays dominant Caucasian features.[35] This raises serious questions regarding ethical issues and stigmatization of non-Caucasian groups. Ethnic differences in beauty must be understood, recognized, and respected. Recent headlines depict extremes of physical ethnic transformations that are far removed from any concept of beauty. Such dramatic transformations can be achieved when plastic surgery is offered to a given patient without restraint from the surgeon.

Lessons Learned From Philosophies Of Art And Beauty

The first formulation of the stereotype "what is beautiful is good" is found in treatises of philosophies of art and beauty in a poem by Sappho.[37] Cognitive sciences confirmed the pervasive effect of appearance on social outcome.[38] Our ethical responsibility directs us to be careful in our statements about any link between appearance and human values: beauty should not be used as a basis for trait attribution.

CONCLUSIONS

The authors are to be congratulated for focusing on a subject at the heart of our specialty: beauty. Prototypes of a population from the same ethnic group can be effectively used as a first-line model for preoperative planning, primarily in facial rejuvenation. The evaluation of the major age markers for each decade allows identification of the major imperfections that most contribute to the aging appearance in order to address them in priority in a sequential manner. Composite 3-dimensional (3D) facial images of individuals selected by age decade within the same ethnic group allow a multifaceted assessment from different angles with a sequential progression of 15°.

3D "superprototypes" from the same ethnic group are more useful as a second-line model mostly for facial beauty enhancement. Attractive composites are more appealing because exaggerating differences in shape show that extreme features are preferred, especially in sexual dysmorphism. A next step would be to evaluate face and neck beauty in motion by studying 3D composites.

Disclosures

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