Circles of Prominence

A New Theory on Facial Aesthetics

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Objective: To elucidate key elements of facial aesthetics through a new hypothesis called the *circles of prominence.*

Design: In this subjective survey, 32 persons in the medical field rated frontal-view photographs of 20 subjects in 5 categories on a 0-to-100 scale, 0 representing the most unaesthetic rating, 100, the most aesthetically pleasing. The study was conducted in an academic setting, and the subject photographs were of 9 women (aged 27-65 years) from a clinical setting and 11 women whose pictures appeared in entertainment magazines. Each subject's eyes, nose, mouth, and chin were subjectively rated for their aesthetic quality. A general rating was also given for the subject's face as a whole. The subject's faces were then analyzed and measured based on the circles of prominence theory. A total of 52 measurements were chosen for the analysis. All raters' numbers for each anatomic unit and the face in general for each subject were averaged. The theoretical measurements were also averaged for each unit. The percentage of the ideal for the face in general was calculated based on weighted averages of the measurements from the individual units of each subject. The Wilcoxon signed-rank test was used to determine whether a significant difference existed between the raters' averages and the averages measured based on the facial analysis. Spearman rank coefficient correlation was used to determine if a significant correlation existed between those means.

Results: We set statistical significance at $P \leq .05$ and found that the mean ratings of 11 of the 20 raters for the face in general were not significantly different from the measured means based on the the circles of prominence theory. There was a significant correlation between the raters' means and the measured percentages of the ideal for all units and the face in general based on the Spearman rank test.

Conclusions: Although the statistical analysis showed that many of the raters' subjective averages were significantly different from the averages calculated on the circles of prominence theory, the trends for those averages showed that the theory has meaningful validity in assessing facial aesthetics. The measured average ratings based on the theoretical calculations were higher than the subjectively rated averages. This was especially true for the photographs of clinical subjects and might be the cumulative result of multiple measured deviations from what is most aesthetically pleasing, thus creating an impact greater than the sum of its parts on the observer's subjective interpretation. The possible synergistic effects of multiple deviations for each anatomic unit or the face in general might have resulted in the much poorer subjective ratings than what the equally weighted, linearly determined measurements could analyze.

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DESPITE THE ATTEMPTS OF numerous articles on facial aesthetics to determine the definition of *beauty*,[1-9] its ultimate qualitative and quantitative characteristics remain elusive. Farkas and colleagues[10] showed in 1985 that the facial characteristics of the neoclassic canon did not represent average facial proportions and so are a poor standard for ideal facial aesthetics. Others agree.[11] Some believe that there exists a divine proportion based on the number phi (ϕ), 1.618, by which the face is divided proportionately.[3,12,13] However, faces that fit into that scheme are not necessarily beautiful.[13]

Perhaps the standard for facial aesthetics lies in the direction of our analysis. The canon has been traditionally based on horizontal and vertical planes of reference in 2 dimensions. It also depends on external landmarks that may have little or no relevance to the observer who encounters a new face. Perhaps we need to concentrate on what the observer actually sees and the analytic process he or she uses to assess what is beautiful. Specifically, our minds identify very subtle gradations of light that help us to subjectively interpret in 3 dimensions. Ganglion cells in the retina are arranged in concentric circles linked by inhibitory pathways that increase the sensitivity of these cells to appreciate borders between light and darkness. The brain is thus highly stimulated by contrast, predisposing our sight to distinguish between gradations of light. Be-
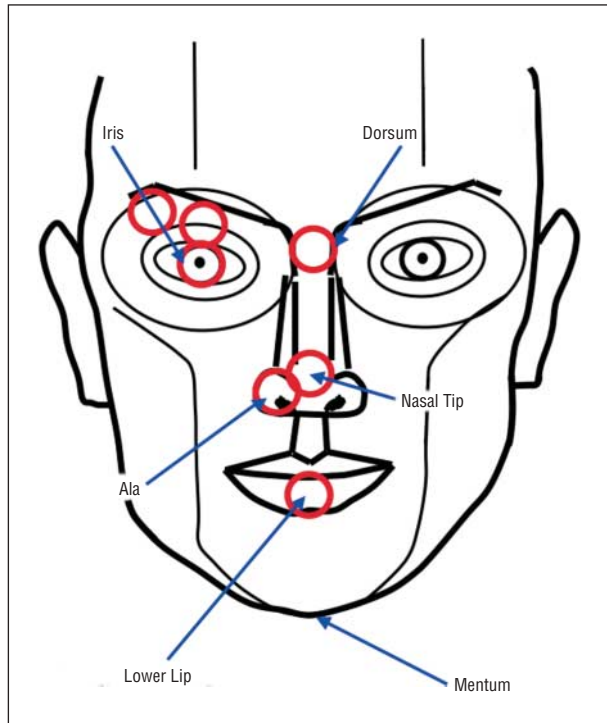
Figure 1. The circles of prominence: a collection of shapes and angles based on the iris, nasal tip, and lower lip that defines facial beauty qualitatively and quantitatively. The iris, nasal dorsum, nasal tip, alae, and lower lip are all 1 iris width in dimension.

Labels in figure: Iris, Dorsum, Nasal Tip, Ala, Lower Lip, Mentum

Figure 2. The basic circles of prominence (COP) are the iris, nasal tip, and lower lip. These shapes serve as centerpieces from which successive COP arise to define the face. Distance between these basic shapes are ideally at 3 iris widths (IWs).

Labels in figure: 3 IWs, 3 IWs

cause of their geometric arrangement, the retinal ganglion cells possibly create a preference for appreciating circular elements as well.

Our perceptions of these subtleties constitute our notions of beauty.[13] We must see no lines, blemishes, or highlights that deviate from this collection of shapes that determine our aesthetics. We must see only gradations of light that demarcate specific shapes, and these shapes must be balanced, symmetrical,[1] and proportionate.

Gradations of light, ironically, might also be the underlying reason why beauty has remained such a mystery. In the past we have relied on the saying "beauty is in the eye of the beholder,"[14] but there has always existed some basic arrangement of shapes in which minor variations (in millimeters) endow uniqueness to each particular face. These minor variations in combination with the subtleties of shading are the elements that have precluded us from precisely identifying the "beautiful" arrangement. These factors can also explain cultural differences in beauty as well. Minor variations may give each ethnicity its own distinction, but in essence the collection of shapes is basically the same, and beauty is similarly interpreted across cultures.[2,4,13]

In addition to the difficulties of definition created by gradations of light, beauty is appreciated preferentially in the right hemisphere of the brain, which is separated from the analytic left hemisphere.[2] Because beauty incites a predominantly emotional response in the limbic system and a large part of our appreciation of beauty is in the subconscious realm, the conscious and analytic part of our mind is further kept from discovering the precise definitions.[2,3,13]
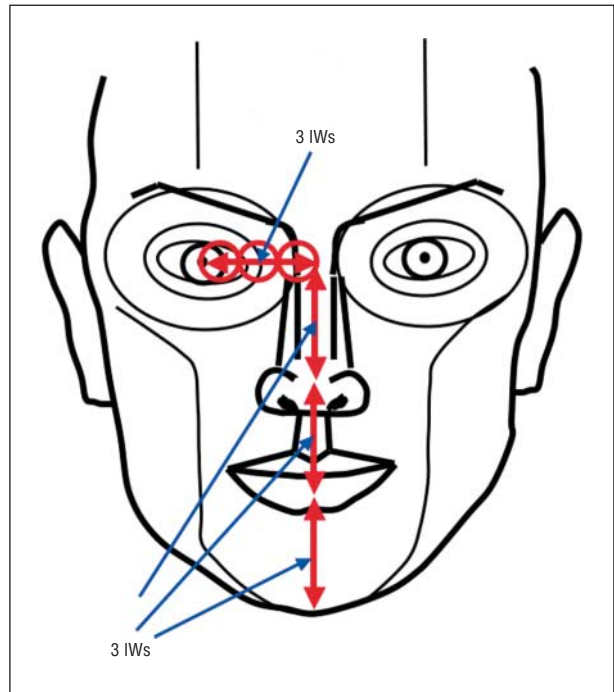
CIRCLES OF PROMINENCE

Circles of prominence (COP) is a unique theory discovered by one of us (P.A.Y.) to explain the ideal arrangement of shapes that make up a beautiful face. Previous work has shown that there exists a hierarchy of interest for the observer when assessing a new face.[9] Studies based on recordings of eye movements show that a person fixates first on the eyes, nose, and mouth, then other landmarks, but returns again and again to the eyes, nose, and mouth. Specifically, the observer fixes the most attention on the iris. The COP theory is based on this vital finding. All subtle shapes, sizes, and dimensions in the face are defined by the iris and, specifically, the diameter of the iris. The width of the nasal dorsum, the diameter of the nasal tip highlight, the diameter of the partial circles formed by the alae, the width of the lower philtrum, the distance from subnasale to upper lip, and the height of the lower lip (**Figure 1**) all should equal 1 iris width (IW).

Incorporating mathematics, we use the values 0 and ∞ (infinity) to help us make judgments on many things in nature, and this certainly includes the human face. **Figures 2**, **3**, **4**, **5**, and **6** illustrate more of these mathematical relationships. (More detailed information on these Figures and mathematical relationships is available in the "Eye COP and Facial Obliques" and "Mouth COP" subsections of Web-only text at http://www.archfacial.com). That we spend so much time focusing our attention on the iris indicates that we perceive the size of the iris as the ideal median between 0 and ∞ for facial stucture size. When the diameter of a facial structure is greater than 1 IW, the attention is drawn away
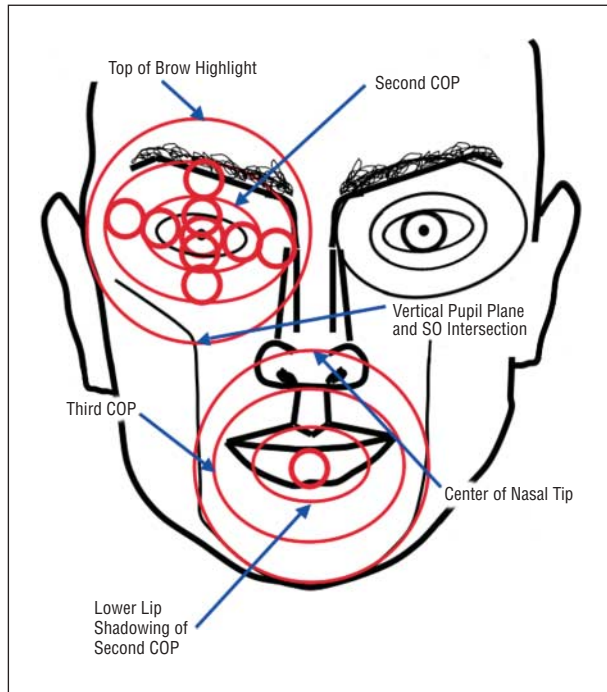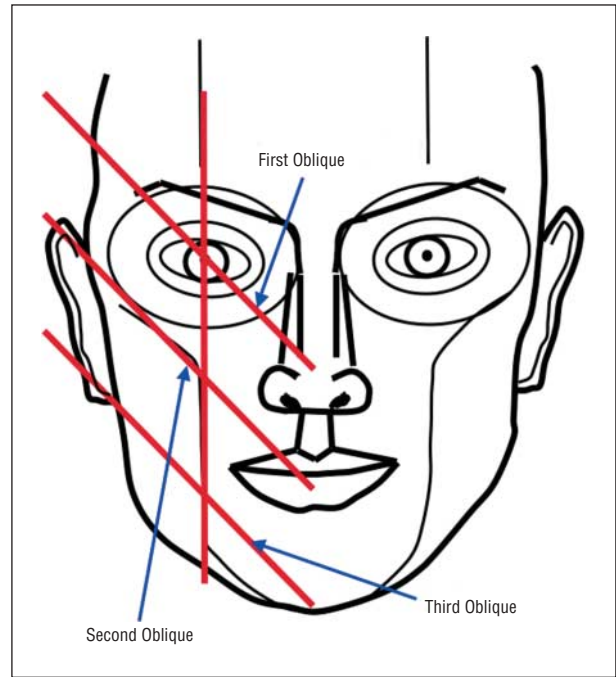
Figure 3. The circles of prominence in the eye and mouth are equal in size and shape. All dimensions of the face are defined by the width of the iris; SO indicates second oblique.

Figure 4. The basic circles of prominence are central in forming 3 obliques and 1 vertical that define the face and bring attention to the eye.

from the iris and other structures that are ideally an IW and toward the larger structure. The ultimate result is that the beauty of the iris and eyes is decreased. When the structure is smaller than 1 IW, less attention is brought to it. Hence, it is better for the structure to be smaller than an IW. However, the smaller the shape is than 1 IW, the less association with other structures it has, and consequently the less harmony, proportion, and balance. Hence, the closer to 1 IW that facial structures are, the more aesthetically pleasing they are (Figure 1).

METHODS

Nine photographs of female patients were randomly selected from a clinical setting and 11 photographs of women from popular magazines were chosen for the study. Each was selected based on several facial aesthetic characteristics. All photographs were frontal views. Models were assigned odd numbers (except subject 20, who was a model), and clinic patients, even numbers (details available in an online eTable [http://www.archfacial .com]). Thirty-two participants in the medical field were asked to rate each picture based on 5 areas: (1) face in general, (2) eye, (3) nose, (4) chin, and (5) mouth. They were asked to assign a number from 0 to 100, with 0 being the lowest aesthetic rating and 100 being the most aesthetically pleasing. For the 4 specific areas, they were asked to judge each area, to the best of their ability, separately from the other anatomic units.

Each frontal picture was then analyzed based on the COP theory by taking specific measurements from each picture. To distinguish one unit edge from another, we used the point at which a 50% change was reached from one unit's maximum shade to the other unit's maximum shade, be it a highlight or shadowing. The parameters were measured, and their distances were then divided by each subject's IW to standardize each picture for individual size differences. The following measurements were taken for each parameter: (1) interpupillary distance; (2) pupil to mid-

line; (3) pupil level to nasal tip; (4) tip to lower lip; (5) lower lip to mentum; (6) palpebral aperture; (7) width of third eye COP; (8) nasal dorsal width at midpoint (horizontal level defined as midway between interpupillary level and supratip break or alar crease); (9) width at nasal base at same midpoint; (10) interbrow width; (11) tip width; (12) alar width; (13) philtrum width; (14) lower lip height at midline; (15) top of eyebrow prominence to second oblique and vertical pupil plane intersect; (16) width of fourth eye COP; (17) subnasale to center of chin highlight; (18) upper eyelid crease to bottom of shadowing produced by lower eyelid; (19) top of eyebrow to center of cheek highlight; (20) lateral canthus to upper eyelid crease; (21) eyelid margin at vertical pupil plane to upper eyelid crease; (22) medial canthus to upper eyelid crease; (23) commissure to commissure; (24) tip to lateral cheek shadowing; (25) horizontal width of fourth mouth COP; (26) width of second COP of the lip (highlight of lower lip puckering); (27) lateral edge of lip unit from pupil vertical plane; (28) nasal base width; (29) upper eyelid crease to eyebrow at the lateral canthus; (30) upper eyelid crease to eyebrow at pupil vertical plane; (31) upper eyelid crease to eyebrow at medial canthus; (32) chin width; (33) lateral edge of third eye COP to lateral facial plane at pupil horizontal plane; (34) facial width at pupil horizontal plane; (35) facial width at zygomas; (36) facial width at mandibular angles; (37) forehead shadowing to midline (at the top of the eyebrow); (38) lateral cheek shadowing from midline at the level of the lower lip; (39) top of upper lip to bottom edge of shadowing produced by lower lip; (40) angle from center of lower lip to commissure; (41) medial eyebrow angle; (42) lateral eyebrow angle; (43) endocanthion to exocanthion angle; (44) angle from center of nasal tip to center of alae; (45) vertical distance of superior helix to second oblique; (46) vertical distance of ear lobule to third oblique; (47) subnasale to mentum; (48) endocanthion to exocanthion; (49) intercanthal distance (endocanthion to endocanthion); (50) lateral plane of face to lateral ear; (51) tip to mentum; and (52) distance of first oblique to center of largest height from lateral canthus to eyebrow.

Distances were standardized and individualized by dividing them by each subject's IW. Because the theory is based on multiples of IW, the distances of the frontal pictures mea-
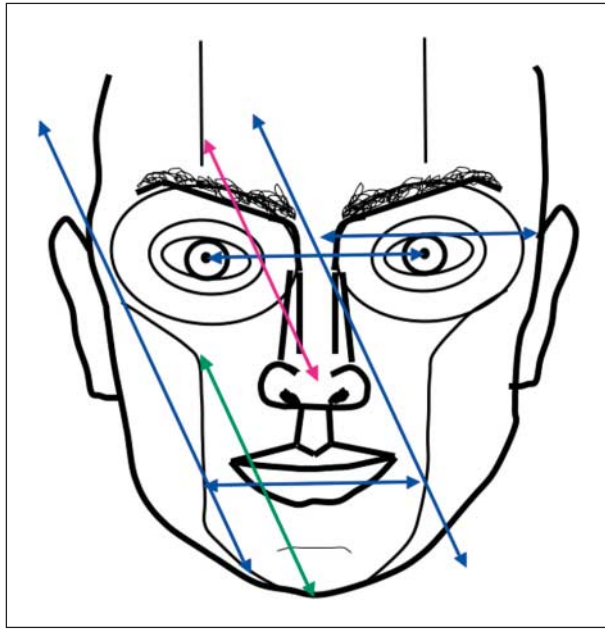
Figure 5. Everything in the face is related. The largest circles of prominence (fourth COP) of the eye and mouth are equal to the interpupillary distance and half-face width.
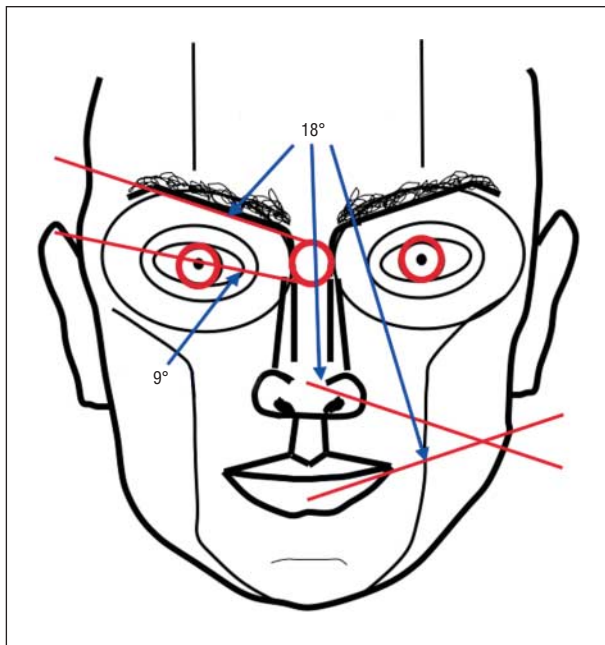
Figure 6. The angles of the medial and lateral eyebrows, nasal tip to alae, and lower lip to commissures are 18°. The angle of the horizontal palpebral fissure is 9°. Everything in the face is related by shape, size and angles.

sured could easily be compared with the ideal distances. To calculate a percentage of the ideal, the lowest aesthetic measurement was set at 0 and the best was set at the ideal distance for each parameter based on the theory.

We evaluated 52 facial areas for percentage of the ideal for each patient. Of those 52, 29 were chosen to further evaluate the eye unit, and 13, 12, and 19 for the chin, nose, and mouth, respectively. Each unit was expressed as a mean by averaging all of the measured percentages of ideal for that particular unit. All parameters were weighted equally, and no multipliers were applied in determining the separate units. For the face in general category, we multiplied each separate unit's mean rating by the number of aesthetic val-

Table. Spearman Rank Correlations Between Raters' Means and COP Parameters Averaged for 20 Subjects for Eye, Chin, Nose, Mouth, and General Face Areas*

	Scores			
Face Area	Subjective Raters	COP Parameters	Correlation Coefficient	*P* Value†
Eye	63.5 (24.2)	76.2 (9.4)	0.76	<.01
Chin	60.1 (25.2)	79.8 (15.4)	0.80	<.01
Nose	55.5 (24.2)	75.0 (13.1)	0.77	<.01
Mouth	63.2 (23.5)	80.1 (13.2)	0.71	<.01
General	62.7 (24.6)	77.7 (11.3)	0.85	<.01

Abbreviation: COP, circles of prominence theory of facial evaluation.
*Unless otherwise noted, data are expressed as mean (SD) values.
†For testing the null hypothesis of no correlation between raters' mean evaluations and established COP parameters.

ues used to analyze that particular unit then added them all together. We then divided that number by 73 (the total of all the measured parameters used for the units: $29 + 13 + 12 + 19$). The weighted means were used to emphasize the units that required more measured values to analyze. For subject 1, for example, the calculation proceeded as follows: $[(85.55 \times 29) + (93.15 \times 13) + (83.33 \times 12) + (92.16 \times 19)]/73 = 88.26$. We compared each of the raters' means with the measured means using the Wilcoxon signed-rank test to see if there was a significant difference between the two (online eTable [http://www.archfacial.com]).

The subjective ratings from the 32 raters and the calculated parameters based on the COP theory were both averaged to determine whether they correlated significantly for the eye, chin, nose, mouth, and general face (**Table**).

RESULTS

The online eTable (http://www.archfacial.com) details the 32 raters' mean scores for each subject's eye, chin, nose, mouth, and face in general. The standard deviations and *P* values for the Wilcoxon signed-rank test are also listed. For example, the eyes of subject 1 of 20 were subjectively rated with a mean (SD) score of 87.3 (12.7). The mean percentage of the ideal based on 29 of the 52 COP parameters was 85.55% (online eTable [http://www.archfacial.com]). That is, her eyes displayed 86% of the ideal aesthetic characteristics based on the COP theory. The raters felt that her eyes reached 87% of aesthetic ideal. There was no significant difference between these scores (*P*=.21).

As a whole for the eye, 8 of the 20 raters' mean scores showed no significant difference from the mean COP scores (*P*≤.05 for all 8) (online eTable [http://www.archfacial .com]). For the chin, only 3 of 20 showed no significant difference between the 2 means. For the nose, 6 of 20 were not significantly different. For the mouth, there were also 6 of 20 that were not significantly different. And for the face as a whole, based on a weighted average of the individual units, 11 of 20 mean scores showed no significant difference between subjective ratings and COP theory scores.

The raters' means and the measured COP means were then analyzed by the Spearman rank correlation coefficient and showed that the means for all the units and the face as a whole demonstrated significantly positive correlations (Table).

COMMENT

Our results show that a large number of raters' mean scores differed significantly from the measured mean percentages of the ideal based on the COP theory. In addition, further analysis reveals that the raters' mean percentages of the ideal were much lower for the less aesthetically pleasing subjects (clinic patients) than were the mean scores determined by the COP theory. The clinic patient scores represented the greater number of significantly different means.

However, there was a significant correlation between the raters' mean percentage of the ideal and the means determined by the COP measurements (Spearman rank correlation), indicating significant validity to this theory's ability to assess facial aesthetics (Table). (For a more detailed explanation of some discrepancies, and for further explanation of the foundations of the COP theory, see the "Discrepancies and COP Foundations" subsection of Web-only text at at http://www.archfacial.com.)

The problem with theories in the past has been the external landmarks that they were based on, which people did not find important. However, these external landmarks were easier to base a theory on compared with subtleties of light that change with the orientation of the face. The COP theory concentrates on the forms that grab a person's attention and proposes a schema by which the mind assembles the shapes of the face and determines whether the face is beautiful. From there, the quantitative elements become better defined. Because the COP is based on mathematics, simple geometry, and what a viewer finds important, these elements together with the adherence to existing anatomy make this theory an original thought that could stand the test of time. The difficulty with this theory is that it is dependent on shades of light. Although exactly the elements viewers' use to judge beauty, these elements are not easy to identify. The use of computers to quantify these grades of shading or differential light projection in photography could aid our appreciation of how these subtleties impact our perception of the face. If we could translate these studies to quantify variances that may be adjustable through surgical means, our ability to improve our patient's lives for the better will be changed forever.

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Correction

Error in Reviewers List. In the Reviewers List published in the May/June issue of the ARCHIVES (2006;8: 154), a reviewer's name was inadvertently left off the list. John Rhee, MD, should have been included as a peer reviewer for 2005.

EYE CIRCLE OF PROMINENCE
AND FACIAL OBLIQUES

For the palpebral aperture, the greater the exposure of the iris, the better, but it should not exceed superiorly past 1 to 2 mm inferior to the superior margin of the limbus and inferiorly below the lower limbus. Crucially, the iris, nasal tip, and lower lip are the primary circles of prominence (COP). To bring more ideal balance and proportion to the rest of the face, all of the larger COP and shapes that emanate from these primary COP should be based on multiples of the iris width (IW). As these shapes increase in size, we also hold an ideal between 0 and ∞ for the distance that separates the larger COP from the smaller, and again, because we spend so much of our time focusing on the iris, the IW, and multiples of it, serves as the ideal measure.

The most important primary COP are the iris, nasal tip, and lower lip. Because progressively larger COP emanate from these structures, the distance between the primary COP should be equal to maintain balance. The most important distance is from the pupil to the midline of the face. The distances from the center of the pupil to the limbus, limbus to caruncle, lateral edge of caruncle to medial edge of canthus, canthus to lateral edge of nasal sidewall, sidewall to lateral dorsal edge, and dorsal edge to midline are ideally all half an IW. Because they are not primary in their importance to the beauty of the face, they are defined by half the IW. The distance totals 3 IWs. In turn, this defines the distances between other primary COP. The distances from pupil to midline, horizontal level of the pupil to center of the nasal tip COP, nasal tip to center of the lower lip COP, and lower lip to mentum should all equal 3 IWs (see Figure 2). The mentum serves as the lower boundary of the face. When these distances are unequal, they bring progressive tension to the circles that emanate from the first and primary COP in their relation with neighboring groups of COP (compare Figures 1, 2, and 3). The result is that a decreased aesthetic value is placed on the observed by the observer.

The next phase of the COP theory deals with 3 oblique lines that an observer visualizes. The first oblique (FO) traverses from the central nasal tip COP through the pupil. The FO centers a COP in the lateral upper eyelid. (Although not a definitive circle, the height of this COP from upper eyelid crease to eyebrow is approximately 1 IW.) The FO and the highlights of the nasal tip and lateral upper eyelid highlight bring attention to the eyes and iris. The arch of the eyebrow is really an evo-

lutionary thinning of the lateral portion of the eyebrow to reveal the lateral eyelid highlight above the upper eyelid crease. The effect of the highlight is important to the beauty of the eye. The lateral upper eyelid highlight stands out prominently because the middle and medial upper eyelid have a darker shade. This highlight adds to the association dictated by the FO and attracts significant attention to the iris. The second oblique (SO) courses in a straight line from the center of the lower lip and is parallel to the FO. It demarcates the upper limit of the cheek shadowing and the top of the superior helix of the ear (see Figure 4). When we smile, the commissures are pulled up by the zygomaticus major toward the top of the ear, accentuating the SO. As the lower lip stays essentially at the same horizontal level, the commissures are brought in line, giving this part of the face dynamic symmetry and balance, further increasing the beauty of the face by accentuating the SO and in turn the other obliques. The third oblique (TO) courses from the mentum and is also parallel to the first 2 and should demarcate the inferior border of the lobule, especially the shadowing produced by the antihelix as it encroaches on the lobule (see Figure 4). To our knowledge, these defining limits represent a new concept on where the ear should be located.[1]

Further adding to these obliques are the vertical lines of shadowing that should bisect the pupil. The differential flattening in the central part of the forehead leads to a vertical demarcation of shadowing that lines up with the pupil, bringing attention to the iris (see Figure 4). The dental arches and their posterior course should also bring vertical shadowing within the cheek that is in line with the pupil, again bringing more attention to the iris. It may be that the development of the sinuses aids in forming these vertical lines of shadowing as part of the evolution of facial beauty. This vertical plane, SO, and TO together demarcate progressive shadowing of the cheek to further direct attention toward the central area delineated by the COP of the eyes, nose, and mouth. These vertical lines are tangential to the main lip unit at the nasolabial and melolabial folds (see Figures 3 and 4).

The COP theory then details another more subtle level within the eye unit (see Figure 3). Beyond the first COP (the iris), the second eye COP (see Figure 3) is delineated by the shadowing created by the upper eyelid crease, lower eyelid shadowing, and the medial and lateral canthi. (Although the shape is more elliptical, we will refer to these ellipses as circles both in the eye and mouth.) The upper eyelid crease and the shadowing below it extending to the eyelid margin should be 0.5 IW. The dis-

tance from the upper eyelid crease to the bottom of the eyebrow should also be 0.5 IW, except in the lateral eyelid. As you approach the lateral eyelid, the superior orbital rim adds to the highlight and should be about 1 IW above the lateral upper eyelid crease, whereas the distance from crease to eyebrow in the middle and medial third is 0.5 IW. The upper eyelid above and medial to the pupil is thus 1 IW, in total, and this height is increased to 1.5 IW as one approaches the lateral upper eyelid highlight. The crease should stay 0.5 IW from the upper eyelid margin from medial to lateral tapering toward the canthi. The lateral eyelid highlight is not necessarily at the lateral canthus; it is dictated more by the FO and the balance that this subtle line brings to the nose and eyes. The lower eyelid should have a shadowing 0.5 IW extending below the margin. In short, the second eye COP is 2 IWs high and 3 wide, delineated by the upper eyelid crease and shadowing extending below it to the eyelid margin, the lower eyelid shadowing, and the 2 canthi. Geometrically, the dimensions of the second eye COP, 2 IWs high and 3 wide, form an ellipse with radius 1 IW centered at the lateral edges of the iris. This same principle applies to the third eye COP (see Figure 3).

The third eye COP is delineated by the top of the eyebrows, lateral edge of the dorsum, center of the cheek highlight, and lateral orbital rim. The center of the cheek highlight is 1 IW below the inferior border of the lower eyelid's shadowing. The vertical dimension should extend from the top of the eyebrow to the center of the cheek highlight, 4 IWs. The medial limit of the horizontal dimension is dictated by the lateral edge of the dorsum (not nasal sidewall), and the lateral limit by the lateral orbital rim, 5 IWs. The third eye COP is 4 IWs high and 5 wide. Again, it is an ellipse with a radius of 2 IWs centered at the lateral edges of the iris. The height of the eyebrows should be, at most, 0.5 IW; any height greater than 0.5 IW attracts attention to itself and away from the eyes, ultimately decreasing aesthetic appeal. Notice how the eyebrow hairs on the superior and inferior edge grow toward the center of the eyebrow axis. The result of this differential hair growth is to delineate a defined line that takes on a specific angle. As the hairs converge in the center, the angle and axis are accentuated.

Although more prevalent in men with prominent eyebrows, a fourth COP can be delineated by the following limits: (1) The superior limit of a highlight, directly above the pupil, produced by the eyebrow's prominence should be 1 IW above the superior edge of the eyebrow. (2) One IW below the inferior edge of the third eye COP, the SO intersects the vertical shadowing in line with the pupil. This is the lower limit of the fourth COP. It demarcates where the cheek shadowing should markedly start to increase inferolaterally. The midline and lateral edge of the face at the horizontal pupillary plane are the (3) medial and (4) lateral limits (see Figure 3). It is a circle 3 IWs in radius centered at the pupil. In short, there are 4 COP in the eye: (1) the iris; (2) the shadowing produced by the eyelids with the canthi 2 IWs high and 3 wide; (3) the lateral orbital rim, top of the eyebrow, lateral edge of the dorsum, and center of the cheek highlight 4 IWs high and 5 wide; and (4) a COP 3 IWs in radius centered at the pupil (see Figure 3).

Importantly, no COP should have any sharp delineation. All of the circles should be demarcated subtly by reflections of light. The transition from one unit or COP to the next is the point where there is a 50% difference from the shade of one unit to the next. Blemishes, wrinkles, and discoloration of any sort markedly detract from the beauty of the ideal face, with all of its shapes in balance, proportion, and symmetry, by violating the highlighting that leads to the circles we subjectively identify.

MOUTH COP

The mouth is equivalent to the eye in terms of having subjectively recognizable COP (see Figure 3). The first mouth COP is the lower lip height, equal to 1 IW. Although it is not an overt conspicuous circle, its height is perceived subconsciously in connection with the other COP (iris, nasal tip, dorsum, philtrum, and alae). This notion applies to the other structures as well; their shapes are subtle, and their sizes should equal or be a proportion of the IW while maintaining their own unique shapes.

The brain has a way of finishing shapes that are unfinished.[2] The second mouth COP begins with the shadowing produced by the downward and inward sloping of the upper lip, 0.5 IW high. It is further formed by the lower lip with its highlight and puckering, 1 IW high. The shadowing below the lower lip should be equivalent to the lower eyelid shadowing, 0.5 IW high, and completes the lower part of the second mouth COP. The vertical distance from top of the upper lip to bottom of the lower lip shadowing should equal 2 IWs. The puckering of the lip should produce a subtle highlight 3 IWs wide, or the width of the second eye COP. Shadowing produced by the commissures and their posterior course, secondary to dental arches as they proceed posteriorly, helps to produce gradual emphasis on the highlight created by the puckering. The height of the lower lip puckering markedly thins after the 3-IW point, as it approaches the commissures. The shadowing of the upper lip and the shade beneath the lower lip should be analogous to the second eye COP eyelid shadowing. All of the associations are with the iris and eye COP to accentuate and associate with it.

These associations continue with the mouth's third and fourth COP. The third extends from commissure to commissure; the distance is 5 IWs and should be equal to the width of the third eye COP. The distance from subnasale to the center of the chin highlight should be 4 IWs and equivalent to the distance from the top of the eyebrow to the center of the cheek highlight. For the fourth mouth COP, the distance from nasal tip to lower lip is the radius, 3 IWs, by which one can draw a circle 6 IWs in diameter centered at the lower lip (see Figure 3). This circle is delineated by the nasal tip, melolabial fold, and the mentum. The width of the main lip unit is also the same distance from midline to the most lateral part of the face at the level of the pupil, 6 IWs (see Figure 5, blue horizontal arrows). It is also equal to the interpupillary distance, further adding to the balance and harmony in the many dimensions in the face.

The fourth mouth COP is not the same shape as the first, second, or third eye or mouth COP: it is nearly a perfect

circle. However the fourth COP of the eye and mouth both demarcate the limits in the eye unit and mouth unit, respectively, while associating with other distances (ie, interpupillary and half-face width distances; see Figure 5, oblique blue arrows). This adds to the subconscious association, along with the other COP, between the 2 anatomic units of the eye and mouth. The fourth mouth COP also aids in the vertical shadowing that is limited by the vertical line bisecting the pupil to help bring attention to the iris, further beautifying the eyes and, in turn, the face in general (see Figure 4). The mentum, or lower limit of the fourth COP, is 1 IW inferior to the third mouth COP; it is analogous to the point where the vertical plane of the pupil intersects with the SO (see Figure 5, green arrow). This is the same association found between the nasal tip and the upper limit of the eyebrow prominence 1 IW above the midpoint of the eyebrow (see Figure 5, red arrow).

In summary, the mouth has 4 COP: (1) the lower lip height that equals 1 IW; (2) the shadowing produced by the upper lip and area inferior to the lower lip along with the lower lip pucker, 2 IWs high and 3 wide; (3) commissure to commissure and subnasale to the center of the chin highlighted area, 4 IWs high and 5 wide; and (4) the COP centered at the lower lip, with a radius equal to the distance from tip to lower lip, a radius of 3 IWs or 6 IWs in diameter (see Figure 4).

Other structures are also delineated by the IW to continue the subtle association with the iris and eyes. The interbrow distance is 2 IWs, delineated by the association between the mouth and eye fourth COP (see Figure 5, long blue arrow). The nasal base from ala to ala is 3 IWs. The chin width is 3 IWs. The bizygomatic breadth is 12 IWs; the bigonial distance is 10 IWs. The ear extends from the lateral part of the face by 1 IW. The nose at its root is 2 IWs and is 3 IWs at the base. The interpupillary distance is 6 IWs (see Figure 5, blue arrow between pupils). Again, equal balance between shapes (equal distances between primary COP), proportion of all shapes (all shapes in multiples of the IW), and symmetry between sides (right and left COP are equal) and within each COP (each COP is symmetric in its own dimension, ie, elliptical or circular, and similar in shape between eye and mouth COP) contribute to a person's beauty.

One issue that has not been adequately addressed by previous publications is the aesthetic importance of the angles at the eyebrows and horizontal eye fissures (see Figure 6). There is also an ideal angle formed by the nasal tip and the centers of the alar prominences. Moreover, an ideal angle exists for the lips, from the center of the lower lip to the commissure shadow. The eyebrow should produce an 18° angle from the medial brow to the arch. This is the same angle (18°) from the arch to the lateral extent of the brow. The third eye COP is 4 IWs high and 5 IWs wide, a proportion of 4/5, 0.8. In addition, $0.2 \times 90°$ is 18°, a coincidental finding. The ideal angle from endocanthion to exocanthion was discovered to be 9°. Other structural relationships that show ideal angles are the tip with the alae and the center of the lower lip with the commissures, both 18°. Because some of the structures (alae, eyebrows, commissures at rest, and canthi) do not fit into the obliques, these angles allow them to associate with other structures in such a

way as to further create balance, symmetry, and harmony. When these angles deviate from the others, tension is created with the shapes involved. Attention is brought to the deviation, and less balance and harmony with the other shapes becomes the subjective result.

The forehead also has an ideal height. As described, the superior limit of the brow prominence should be 1 IW from the superior midpoint of the eyebrow. This is the upper limit of the fourth eye COP (see Figure 3). Above this point, the trichion should not be more than 3 IWs high. In short, the distance from the pupil to the forehead should not exceed 6 IWs, or the distance from pupil to lower lip. As this distance from pupil to trichion approaches the distance from pupil to lower lip, it approaches the ideal. When the forehead is taller, attention is directed to this unit. When it is smaller, there is less association or harmony with the central face found between the pupil and lower lip. Both situations occur at the expense of ideal aesthetics.

The theory is subtle because it is based on shades of light. It is based on the most important structure of the face, the iris. Simply put, there are multiple shapes on the face and an evolutionary force must have determined the specific size of each of those shapes. Extremes in dimensions are unaesthetic. Between the extremes must be an ideal that the mind settles on and prefers. The iris is the center of attention in the face and should therefore be the structure that every dimension on the face is based on.

DISCREPANCIES AND COP FOUNDATIONS

The discrepancies between the raters' scores and those determined by COP may be explained by the way the percentages of the ideal were measured under the COP theory. All parameters were essentially linearly determined. That is, the ideal was set based on the theory, and the linear increment by which each subject fell short of the ideal equaled a coinciding percentage short of the ideal. Except for the general means that were weighted with the different units, no other multiplicative factors were involved, nor were any individual parameters weighted more than others. The finding in some instances that the raters' scores were markedly lower than the COP theory scores indicates that very small, very subtle variations greatly affect aesthetic judgments. Perhaps different multipliers would bring the theory more in line with subjective ratings. Alternatively, if some parameters impact the viewer more than others, those more important parameters could be weighted more heavily as the COP theory is developed.

The formulation of this theory began with the understanding that symmetry, proportion, and balance are important aspects of any structure that is a compilation of different shapes.[2] The shapes that attract the most attention on the face are the irises, followed by the nasal tip and the lips.[3] An observer's gaze then shifts to other shapes, then returns again to the iris, then repeats this cycle to continue analyzing. In regard to the neoclassical aesthetic canon, it does not seem likely that an observer would concentrate on the trichion, glabella, or other insignificant external landmarks that occupy prominent places in the canon.

These structures are not important to the observer. Rather, a new theory should focus on what an observer actually concentrates on, namely the iris.

Because the iris, tip of the nose, and lower lip are the most prominent facial features, they need to be equal in size (see Figure 1), and the distances between them should be equal. Since each of the smallest COP represent the base for larger COP, any deviation in distance between them will bring tension into the relationships between the larger COP.[2,3] All of the structures of the face emphasize the iris, including the vertical forehead and cheek shadowing, which should line up with the pupil in a vertical plane, as well as the obliques and other primary COP. The shapes in the mouth are related to the shapes in the eyes. All of the COP in each of these anatomic parts should be equal in shape and size. Notice how the dimensions of the first through fourth COP are the same shape in the eye and mouth units. The subconscious result is that when a person speaks, smiles or sings, the mouth brings to life the eyes and subsequently the face as a whole.

This theory that an ideal exists is supported in the literature. One study showed that humans have an innate ability to distinguish beauty regardless of cultural differences in facial appearance.[4] Babies as young as 3 months showed a marked preference for attractive faces, as defined by adult preferences. Different cross-cultural studies also support the presence of this innate human tendency to define as *beautiful* a basic compilation of facial shapes that transcends ethnic variables in facial architecture.[3,4,12] These works also suggest that this theory could be applicable across ethnicities. Asians and African Americans have their own unique variations that distinguish them from other ethnicities. They are accepted as the norm in their cultures but the compilation of the different shapes of the face, their arrangement, balance, and proportion are essentially the same in adherence to the COP theory. The minor differences may be what heightens a particular individual's beauty by showing the viewer a unique representation of beauty adherent to the COP theory while heightening a factor based on cultural familiarity.

The ideal angles formed by the eyebrows, nasal tip and alae, lower lip and commissures, and canthi are defined by COP theory as either 18° or 9° (see Figure 6). In Figure 4, the obliques are 45° from the horizontal. The angle formed by the mentum to the point where the SO intersects the vertical plane through the pupil should be 67.5° or midway between 90° and 45°. This is also true of the angle formed by the line connecting the nasal tip and the superior edge of eyebrow prominence that is in line with the vertical plane through the pupil (see Figure 5, red and green arrows). In short, the angle 67.5° is essentially the angle associating the mouth with the eye. The alignment of the other structures within the face to specific angles (ie, nasal tip/alae, lower lip/commissure, endocanthion to exocanthion) at 18° and 9° brings balance to these structures that do not fit within the confines of the obliques and eye/mouth angles. In total, all of the structures and shapes of the face are ideally adherent to either 90°, 67.5°, 45°, 18°, 9°, or 0°. The result is again symmetry, balance, and harmony to all of the structures of the face. The ultimate result is beauty.

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eTable. Evaluation of Aesthetic Characteristics by Subjective Raters and by Measurements Based on the Circles of Prominence Theory*

Subject No.	Eye	P Value†	Chin	P Value†	Nose	P Value†	Mouth	P Value†	General	P Value†
1	87.3 (12.7) 85.55	.21	73.8 (20.8) 93.15	<.01	75.5 (20.6) 83.33	.16	83.8 (17.8) 92.16	.02	84.6 (12.0) 88.26	.16
2	32.4 (20.3) 56.93	<.01	27.8 (14.8) 63.46	<.01	40.5 (23.2) 59.25	<.01	40.3 (15.3) 62.47	<.01	34.5 (17.0) 59.92	<.01
3	75.7 (19.1) 84.48	.08	76.5 (19.4) 89.85	<.01	77.7 (19.7) 82.83	.41	87.6 (14.0) 87.95	.42	86.2 (13.3) 86.07	.32
4	39.5 (19.5) 75.38	<.01	28.4 (13.5) 76.92	<.01	23.3 (15.2) 72.75	<.01	38.1 (22.0) 76.79	<.01	34.8 (16.7) 75.59	<.01
5	89.1 (11.7) 81.55	<.01	81.3 (17.6) 92.08	<.01	76.1 (20.2) 94.67	<.01	80.0 (17.2) 90.89	<.01	84.5 (12.3) 88.01	.19
6	37.7 (24.4) 73.72	<.01	29.3 (17.3) 52.38	<.01	24.5 (17.1) 55.58	<.01	42.3 (21.2) 61.74	<.01	36.3 (15.8) 63.82	<.01
7	82.0 (16.4) 84.14	.87	75.8 (19.0) 91.62	<.01	71.3 (21.4) 83.67	<.01	77.0 (19.5) 89.47	<.01	80.3 (13.0) 86.78	.06
8	20.2 (11.3) 62.03	<.01	16.5 (11.4) 44.85	<.01	27.3 (17.9) 60.08	<.01	28.2 (16.8) 49.47	<.01	26.0 (13.5) 55.38	<.01
9	82.2 (20.1) 87.69	.43	85.3 (16.4) 89.62	.93	77.3 (21.7) 84.33	.32	86.4 (13.6) 89.68	.96	83.6 (15.8) 88.00	.32
10	38.3 (23.1) 62.62	<.01	38.5 (19.1) 53.23	<.01	34.4 (23.9) 47.00	<.01	43.1 (21.0) 58.53	<.01	40.8 (20.3) 57.32	<.01
11	82.6 (17.4) 78.93	.04	79.3 (20.4) 89.00	.02	66.0 (23.6) 84.75	<.01	80.7 (17.0) 88.58	.02	79.1 (17.2) 84.19	.37
12	46.3 (27.8) 63.14	.85	47.3 (23.4) 82.85	<.01	49.8 (22.9) 74.33	<.01	38.2 (23.4) 79.05	<.01	45.6 (23.8) 72.63	<.01
13	85.8 (11.9) 78.28	<.01	83.4 (13.8) 92.00	<.01	78.0 (18.6) 88.50	<.01	79.0 (19.6) 92.53	<.01	81.8 (13.6) 86.11	.24
14	25.3 (20.4) 75.14	<.01	20.4 (15.3) 65.00	<.01	11.1 (11.0) 58.67	<.01	19.8 (18.0) 64.53	<.01	19.3 (13.1) 67.86	<.01
15	72.8 (20.5) 84.62	<.01	73.1 (21.1) 80.77	.14	75.7 (21.1) 77.08	.52	81.5 (19.6) 84.89	.34	81.1 (16.4) 82.77	.62
16	71.1 (18.9) 72.28	.63	71.0 (16.5) 87.15	<.01	48.2 (22.2) 73.50	<.01	59.4 (18.5) 85.84	<.01	60.1 (13.8) 78.66	<.01
17	87.3 (13.1) 88.48	.91	82.8 (17.9) 92.08	.04	78.7 (21.0) 86.33	.14	82.9 (19.7) 90.63	.08	84.2 (17.0) 89.33	.19
18	48.1 (26.4) 67.24	<.01	44.2 (22.1) 80.15	<.01	23.7 (18.8) 66.00	<.01	44.4 (22.6) 81.95	<.01	40.9 (16.7) 73.16	<.01
19	86.4 (15.3) 80.69	<.01	90.0 (10.9) 89.77	.16	84.2 (17.9) 82.58	.15	88.4 (14.9) 87.32	.07	90.8 (11.0) 84.34	.07
20	79.2 (20.2) 81.28	.77	77.0 (18.8) 90.85	<.01	66.4 (27.0) 85.25	.01	83.7 (11.9) 87.58	.15	79.5 (17.5) 85.27	.21

*Unless otherwise noted, data are reported as raters' mean score (SD of raters' mean score) circles of prominence measured mean scores. The scoring range was 0 to 100, 0 being least aesthetically pleasing, 100 being the most.

†P values based on Wilcoxon signed-rank test.