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Eye and Lips in Artistic Profiles

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Distortions related to eye and lip morphometry were investigated in two studies comparing photographic versus artistic profiles. In the first study, 298 artistic profiles encompassing the whole art history were compared to 300 photographic profiles. The 2 groups were compared for shape with Procrustes analysis and for size by using 8 indexes. Estimated age was inserted as covariate. The results showed that artists exaggerated eye height and width, pupil width, lip height, and width. The triangular shape of the eye view from side perspective was modified toward a more ellipsoidal shape, depicting the eye from a threequarter and more frontal perspective. In Study 2, 13 students from the College of the Arts–School of Art were requested to draw a profile portrait of a male or female model. The eye and lip morphometric indexes of the model were compared with those extrapolated from the drawings. The results confirmed an exaggeration of eye width and height, lip width, and pupil width in artistic profiles. Additionally, the eyes shape was "frontalized." The exaggeration of eye and lip size and the distortion in shape are interpreted and discussed according to the theory linking supernormal stimuli to aesthetic perception.

Keywords: portraits, profiles, art, face, eyes

Figurative art is the result of two coexisting forces: to imitate in shape and size a specific subject, and to distort/transform the subject in order to convey a more "artistic," "aesthetic" value. In this perspective, distortions in arts can be interpreted not only as introduced "noise" due to technical limitations of the artist in reproducing with realistic fidelity a specific subject, but also as a systematic mean to convey artistic and psychological/perceptual values (Deregowski, 1984). The differentiation between the two types of distortions could be ascertained examining the systematicity of the distortions introduced by artists in different cultural milieu and comparing artist renderings of a specific object of figure in different time periods.

The quest for specific markers that differentiate artistic versus non artistic stimuli has shown that, on average, the Fourier spectral power of art images tends to fall with spatial frequency according to a power law $1/f^p$, where p is about 2 (Graham & Field, 2008; Graham & Redies, 2010; Redies et al., 2007; Redies et al., 2008). This implies that art images are more roughly scale-invariant (i.e., fractal-like) than real counterparts. Specifically, Redies et al. (2007) have compared photographs versus artistic portraits of human faces, founding that artistic portraits had Fourier characteristic typical of natural scenes rather than real faces. Additionally, statistical studies on the compositional level have shown a tendency in representational art toward identifying and exaggerating distinctive features in the manner of caricature (Ramachandran & Hirstein, 1999), a phenomenon that has been described also in Paleolithic cave painting (Cheyne et al. 2009).

Along this line of research of statistic distinctive features of representational art, in this paper we have compared the statistical morphometric properties of eye and lips in artistic and photographic profiles. The comparison was pursued along two strategies: (a) comparing a large historical corpus of artistic profiles with a wide dataset of photographic profiles (Study 1), and (b) comparing profile drawings of a model made by students of an art academy with the model's photographic profile (Study 2). In both cases, eye and lip morphometric measures were computed and compared between the artistic and the photographic profile.

The face has a privileged status in human perception and in art, being the body part that mostly convey a person's identity and expression. Additionally, the human face represents the main channel of nonverbal communication (Bruce & Young, 2012; Perrett, 2012). Studies on eye movements have highlighted that eyes and lip are the facial features that are mostly fixated during the perception of naturalistic and artistic faces (Rosenberg & Klein, 2014; Yarbus, 1967). This is the reason why in this study we specifically focused on eye and lips in profiles.

Due to the importance of eyes in communication, it could be suggested that artists would tend to retain a frontal perspective of the eyes also when the face is depicted in profile. In a profile, the eyes cover a very little area and have a rather triangular shape in comparison to a frontal view when the eyes are fully visible, and the shape is elliptical. For this reason, the artist could improve a profile artistic value increasing eye size and depicting the eye with a more "frontal" shape. This "frontalization" of the eye was a robust phenomenon in ancient art, being very common in Egyptian, Greek, and Roman art with the twisted perspective in which frontal and profile views were combined. The artist combined multiple viewpoints for the different features that composed a figure. The viewpoints were chosen in order to convey the most distinctive image of each feature. The face, for example, has a more distinctive silhouette when viewed in profile, and therefore the profile view was the most common view of depicting faces in ancient art. The eye, however, exhibits a more distinctive shape when viewed from the front. The result was that the heads were almost always depicted in profile view with the eye represented from a frontal view. Although not as manifest as in ancient art, we hypothesized that this twisted perspective was a constant bias in profile portraits along the whole art history. The profile remained the most common view for depicting faces in art until the 15th century. This view tends to concentrate the observer's attention onto the head shape, with an emphasis on the nose and chin silhouettes. Since the profile view does not allow for any contact to be made between the sitter and viewer and tends to render a flat rendering of the face, from the 15th century onward the threequarter profile became very common. The three-quarter view allows for contact with the viewer, and emphasizing the face perspective, offers a more three-dimensional perception of the face (Sturgis, 1998). The orientation of the face in a portrait has significant effects on face perception, recognition, and memory. For example several studies have found an advantage in recognition memory of three-quarter over full-frontal and profile representations of faces (Krouse, 1981; Logie et al., 1987). In a developmental perspective, Fagan (1979) observed superior recognition memory for a three-quarter pose in infants.

Distortions in size are often encountered in art as a cue for conveying depth perception or specific psychological meanings (Deregowski, 1984). The relative size of coplanar figures, for example, is often related to social dominance and ranking. The use of size to indicate differences in status was common even after the widespread adoption of perspective. Indeed, what is more central in the message that the artist wants to convey tends to be oversized (Deregowski, 1984).

The present study is an extension to profiles of the methodology adopted by Costa and Corazza (2006) on full-frontal portraits. They compared eye and lip size and roundness, and lower-face roundness between 776 artistic portraits and 289 control photographic portraits. The results showed that eye roundness, lip roundness, eye height and width, and lip height were significantly higher in artistic portraits compared to photographic portraits. Lip width and lower-face roundness, on the contrary, were significantly lower in artistic than in photographic portraits. These results were further confirmed testing art-academy students that were requested to draw two self-portraits, one with a mirror and one by memory, without a mirror. Also in these cases, eye and lip size and roundness were significantly increased in artistic self-portraits in comparison to the same morphometric indexes assessed in photographs.

Another example of distortion by exaggeration in the artistic domain is to be found considering head canting degree in Madonna paintings, that exceeds the normal head tilting of women in photographic portraits (Costa et al., 2001). This exaggeration is probably functional to conveying femininity, submission, tenderness to the Madonna. To the contrary, expressions of dominance and sacredness are often conveyed by exaggeration of height (Costa & Bonetti, 2016).

Distortions in shapes in the arts could be caused by a process of geometrical regularization in which complex shapes are regressed toward euclidean primitives as, for example, squares, triangles, rectangles. This process is well-known in the memory of space and geographical units (Costa & Bonetti, 2018), and in the reproduction and memory of visual shapes (Gibson, 1929).

Previous literature has demonstrated a bias in artistic portraiture in relation to face orientation. Indeed, the left side of the sitter's face was more often turned toward the observer than the right side (Conesa et al., 1995; Gordon, 1974; Lindell, 2013; McManus & Humphrey, 1973; Nicholls et al., 1999; Nicholls et al., 2002; Powell & Schirillo, 2009). This "cheek bias" is stronger with women than men, and it has been associated to hemispheric asymmetries in emotional expressivity (Lindell, 2013). Additionally, this bias tends to vary in accordance to the artistic historical period (White, 2019).

The two major hypotheses that were tested in the two studies presented in this paper were that artistic profiles, when compared to photographic profiles matched for sex and age, are characterized by (a) an exaggeration of eye and lip size; (b) a "frontalization" of eye shape so that its perspective would be more frontal in comparison to the proper side perspective. In the first study, we compared facial morphometric indexes extracted form a very large sample of artistic profiles, encompassing the whole history of art, with a control sample of photographic profiles. In the second study, students from the College of the Arts—School of Art of Bologna had to draw a profile portrait of a model. Afterward, facial morphometric indexes of the artistic profile were compared with the real morphometric indexes from the photographic profile.

Study 1

Method

Artistic Profiles

The sample of artistic profiles was extracted from the Scala Picture Library (Scala Archives). The Scala Picture Library is one of the largest fine art image archive worldwide, covering different ages and museums from a worldwide scale. Each image is tagged with keywords allowing queries of the database. For the purpose of the study the database was queried with the keyword "profile." The results were filtered according to these criteria: (a) face rotated by 90°; (b) painted or drawn face (no photograph); (c) face area that could be inscribed in a square of at least 300 300 pixels, to allow an accurate marking of the morphometric landmarks; (d) face not depicted in an abstract style with eyes, lip, nose and face outline clearly marked; (e) portrayed person not being a child or a very old person; (f) lip and cheek not covered by beard, and the eye not covered by hair; (g) gaze not directed down with the eye largely covered by the eyelid. These criteria led to the inclusion of 298 artistic portraits depicting 139 males ($M_{\text{age (estimated)}}$ 35.22, SD 11.89) and 159 females ($M_{\text{age (estimated)}}$ 24.19, SD 6.70).

Photographic Profiles

The sample of photographic profiles included 300 pictures. They were obtained from composite sources: 200 profiles were from the database described in Minear and Park (2004): a very large database of full-frontal and profile high-quality digital face images of both males and females in the age range from 18 to 93. The remaining 100 profiles were extracted from social media and Google image service. This choice was motivated by the necessity to match as much as possible the distributions of sex and age in photographic profiles and in artistic portraits (see Figure 1). For these

100 additional profiles we applied the same validation criteria of artistic profiles. The photographic profiles included 180 females ($M_{\text{age (estimated)}}$ = 30.82, SD = 10.27) and 120 males ($M_{age(estimated)}$ = 31.80, SD = 9.89).

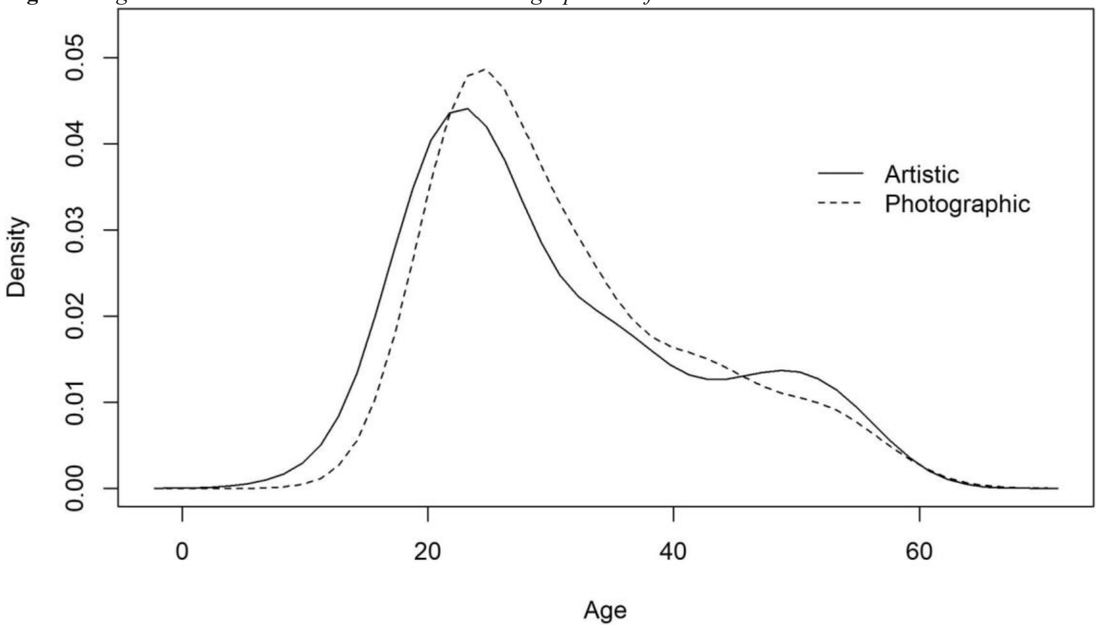
Since the facial morphometric indexes are significantly affected by age, this parameter was inserted (as estimated age when chronological age was not available) as covariate in the statistical analyses. For the artistic profiles and the photographic profiles from social media and Google image database the age was estimated by two independent raters. The average between the two raters for each profile was entered in the statistical analyses. The agreement between the two raters was r .72. According the previous study of Voelkle et al. (2012), age estimation from face images tends to have an accuracy of 7.17 years for young faces, 6.61 years for middle-aged faces, and 6.71 years for older faces. For the photographic profiles from the Minear and Park (2004) database age was extracted directly from the database info.

For artistic profiles age estimation was further complicated by the additional filter introduced by the artist in rendering a specific face in an artistic medium. The distributions of estimated age for the artistic and photographic sample is reported in Figure 1. A oneway ANOVA that tested the difference in age between the two groups was not significant ($p < .13$).

Data Analysis

The data for artistic and photographic portraits were analyzed separately for shape and size, and separately for the eye and the lip regions. The eye region analysis included these landmarks: eye upper point, eye lower point, eye front edge, eye posterior point, pupil anterior point, pupil posterior point, nasion, menton (see Figure 2). The lip region analysis included six landmarks: stomion, labiale superius, labiale inferius, lip outer commissure, nasion and menton (see Figure 2). Nasion and menton were inserted in both regions to assess the positioning of the eye and lip region within the face. The analysis of shape was aimed to capture the shape variation between artistic and photographic profiles removing the effects of size, rotation and position of the face within the image by applying a generalized Procrustes analysis. The morphometric analysis of shape was performed with the *shapes* package in R (Dryden & Mardia, 2016). First the centroid of the landmarks for each profile was computed. The centroid was defined as the point with x and y coordinates equal to the mean of the x and y coordinates of the landmarks included in the analysis. Then, each landmark was connected to the centroid and rescaling of the coordinates was performed, so that sum of squares of the distances was scaled to unity (one). In the following steps, all the shapes were superimposed on the centroid, and each shape was rotated to minimize the sum of squared

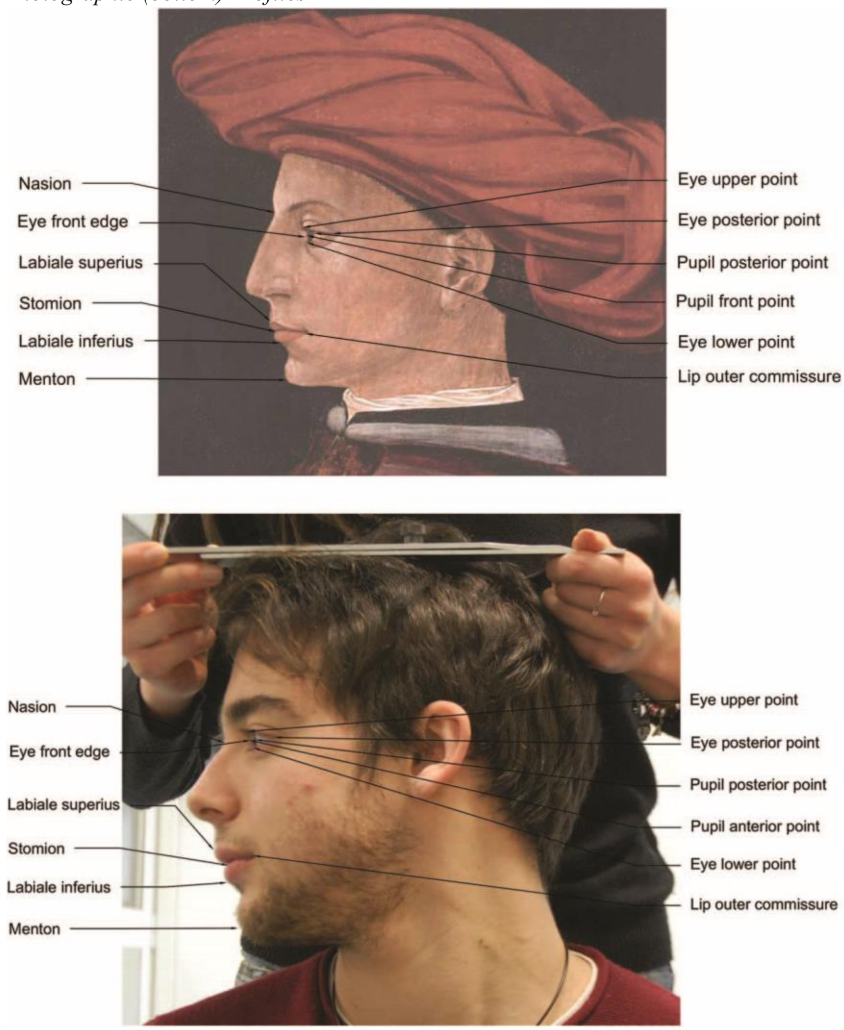
Figure 1. *Age Distribution Between Artistic and Photographic Profiles*



Note. For artistic profiles and for part of the photographic profiles age was estimated.

Figure 2

Facial Landmarks Used for Morphometric Analyses in Artistic (top) and Photographic (bottom) Profiles



Note. Top figure: Masaccio, A young man in a scarlet turban. About 1425-1427. Isabella Stewart Gardner Museum. Image retrieved from https://www.gardnermuseum.org/experience/collection/10786 and licensed in the Creative Commons. See the online article for the color version of this figure.

distances between matched landmarks (Dryden & Mardia, 2016). This data processing results in the Procrustes residual coordinates that were then used for comparing the shapes of the eye and lip region in artistic and in photographic profiles. Canonical variate analysis with parametric *t* test was performed on Procrustes coordinates to statistically test the difference between artistic and photographic profiles for eye and lip shape. Mahalanobis distance and Procrustes distance were computed as parameters of the difference between the two mean shapes.

Size analysis, for each profile, either artistic or photographic, was based on the following indexes (euclidean distances): (a) eye width (eye front edge—eye posterior point)/face height; (b) eye height (eye upper point—eye lower point)/face height; (c) nasion-eye front edge/face height; (d) pupil width/eye width; (e) lip height (labiale superius—labiale inferius)/face height; (g) lip width (stomion—lip outer commissure)/face height. Face height, as reference measure for standardization in size was computed by the difference of menton and nasion coordinates. TpsDig2 ver. 3.2 (Rohlf, 2009) was used to record all morphometric landmarks coordinates. The software allows to zoom in, to increase the precision of landmark positioning. All landmarks were recorded by one of the authors.

In the analyses for size, to normalize all profiles to a same scale all the morphometric measures were standardized to face height (nasion—menton distance). Eye and lip size were therefore investigated on a basis of common face height. Statistical analyses for size were performed with a MANOVA including sex, profile category (artistic vs. photographic) as factors, the eight morphometric indexes as dependent variables and age as covariate. Since estimated age was entered as covariate, we reported the results using estimated marginal means that were adjusted taking into account the effect of age. The estimated marginal mean shows the means for each level of a factor at the mean value of the covariate. When reporting the results for estimated age we also included the Pearson's correlation between age and significant morphometric indexes.

Results

Orientation in Artistic Profiles

The distribution of left and right face orientation in artistic profiles was tested with a chi-square test. Left profiles (N 167, 56%) significantly outnumbered right profiles (N 131, 44%):
2 4.34, $p = .03$.

Shape

Mean shapes for the eye in relation to nasion and menton landmarks, as resulted from the Procrustes analysis, are shown in Figure 3. The canonical variate analysis for eye morphometry between photographic and artistic profiles showed a Mahalanobis distance among groups of 3.11, $p < .001$, Procrustes distance among groups was 0.13, $p < .001$.

Mean shape for lips, as resulted from the Procrustes analysis, are shown in Figure 4. The linear discrimination analysis for lip morphometry between photographic and artistic profiles showed a Mahalanobis distance among groups of 0.78, $p < .001$. Procrustes distance among groups was 0.11, $p < .001$.

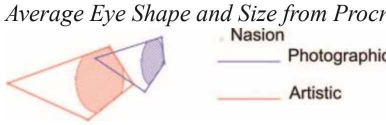
Size

The morphometric indexes in the artistic and photographic groups, along with the results of the MANOVA are reported in Table 1. For all the six morphometric indexes the difference between artistic and photographic profiles was significant. Specifically, in artistic profiles the eye was depicted larger (76%), higher (31%), and at a greater distance from the nasion (60%). Moreover, the pupil was larger (11%) in comparison to control photographic profiles. Significant increases were also recorded for lip height (29%) and width (94%).

Estimated age, inserted as covariate, was significant for eye height [$F(1, 414)$ 22.38, $p < .001$, $\eta^2 = .05$, $r_{Pearson}$ .42], eye width [$F(1, 414)$ 10.35, $p < .001$, $\eta^2 = .02$, $r_{Pearson}$ .32], nasion - eye front edge [$F(1, 414)$ 6.66, $p = .01$, $\eta^2 = .01$, $r_{Pearson}$ .13], pupil width/eye width ratio [F(1,

Figure 3

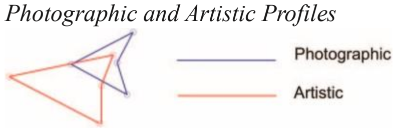
Average Eye Shape and Size from Procrustes Analysis in Photographic and Artistic Profiles



Note. The Size was equalized to nasionmenton distance in the two groups. See the online article for the color version of this figure.

Figure 4

Average Lip Shape and Size From Procrustes Analysis With Reference to Photographic and Artistic Profiles



Note. See the online article for the color version of this figure.

414) 6.56, $p = .01$, $\eta^2 = 01$, $r_{Pearson}$ .47], lip height [$F(1, 414)$ 72.39, $p < .001$, $\eta^2 = .11$, $r_{Pearson}$ .16]. Age did not significantly covaried with lip width (p < .36).

Differences between males and females were significant for eye height [$F(1, 414)$ 22.92, $p < .001$, $\eta^2 = .05$, M_{males}: 0.098 (SE: .002), $M_{females}$: 0.110 (SE: .002)], eye width [$F(1, 414)$ 7.63, $p < .006$, $\eta^2 = .02$, M_{males}: 0.146 (SE: .003), $M_{females}$: 0.160, (SE: .004)], nasion—eye front edge [$F(1, 414)$ 7.13, p =.008, η^2 = .02, M_{males}: 0.123 (SE: .003), M_{females}: 0.135, (SE: .004)], lip height [$F(1, 414)$ 6.06, p = .01, η^2 = .01, M_{males}: 0.113 (SE: .003), M_{females}: 0.122, (SE: .002)].

Discussion Study 1

The statistical shape and size analysis of artistic profiles encompassing the whole art history compared to a control sample of photographic profiles has outlined remarkable differences related to eye and lip morphometry. The eye shape in artistic profiles had a more elliptical shape in comparison to the typical triangular shape found in photographic profiles. The elliptical shape had a vertical asymmetry that is proper of an eye in three-quarter view. This effect shows that artists tend to "frontalize" the eye perspective in profiles, with a shape representing an intermediate rotation between the full-frontal and the full-profile view.

Eye height, on average, was increased with a magnitude ratio of 2.51 in artistic profiles and eye width was increased with a magnitude ratio of 2.76. Lip differed in artistic profiles particularly for shape and size. The "triangular" shape of lips in lateral view was elongated in artistic profiles, lip height was increased with a magnitude ratio of 1.29, and lip width was increased with a magnitude ratio of 1.94.

Although considering large corpus of artistic and photographic profiles could allow a comparison of facial morphometry between the two groups, the comparison remained intrinsically indirect and between profiles that are not referred to the same persons. Therefore, to complement these results, we have performed a second study in which the artistic profiles were directly compared to the photographs of the person depicted in the profile itself. Art students were enrolled for this purpose. They were blind to the aims of the study and requested to draw a profile of a male or female model. The same statistical shape and size morphometric analyses used in the first study was applied to the data of the second study. The hypotheses were that in the artistic depiction versus the photograph the eye and lips would be increased in size and that the eye and lip shapes would be modified toward a more "frontal" perspective. Even if the second study relied on a lower number of drawings, the comparison was intrinsically "within," allowing a more stringent causal link between the differences found in the artistic profile in comparison to the control photographic profile.

Table 1

Standardized Facial Morphometric Comparisons Between Artistic and Photographic Profiles and Results of the MANOVA Analysis. Values for the Artistic and Photographic Groups Are Estimated Marginal Means and Standard Errors Considering Age as Covariate

Morphometric parameter	Artistic	Photographic	F	p	η^2
Eye height/Face height	.119 (.002)	.091 (.001)	117.86	.001	.22
Eye width/Face height	.197 (.004)	.112 (.003)	262.51	.001	.42
Nasion—Eye front edge/Face height	.160 (.004)	.100 (.003)	120.09	.001	.21
Pupil width/Eye width	.376 (.010)	.340 (.005)	9.43	.002	.02
Lip height/Face height	.133 (.05)	.103 (.03)	60.39	.001	.11
Lip width/Face height	.179 (.09)	.092 (.04)	167.68	.001	.25

Study 2

Method

Participants

Thirteen students from the College of the Arts—School of Art in Bologna participated in the study (11 females), M_{age} 23.45 years (SD 0.93) and 2 males M_{age} 30.5 (SD 6.36). On average, years of formal education in fine arts were 8.69 (SD 4.60).

Procedure

Each student had to draw a profile of a model. The model could be either a male or a female person (see Figure 5). The model was assigned by the experimenter dividing the participants into two groups (seven participants for the male model and six participants for the female model) that were placed in two separate parts of the classroom. Therefore, each participant had to complete the drawing of only one model's profile. The models were professional models hired by the College of the Arts—School of Art in Bologna and had not served as models for the participants in previous drawing sessions.

Participants were informed about the exact aims of the study only at the end, having already finished and delivered the profile drawing. The study was presented as an exercise of figurative drawing in the course of artistic anatomy. The students were instructed to draw as accurately as possible only the face retaining their artistic style and without making an abstract portrait (eye, lips, nose and face contour had to be clearly outlined). They were allowed to use a pencil, a charcoal pencil or crayons.

Figure 5

Profiles for the Male and Female Model Used in Study 2

Note. See the online article for the color version of this figure.

The model was requested not to move retaining a neutral expression and looking ahead for 20 min. The female and male models were arranged in the same room in opposite corners, and the students were seated in front of the model so that their lateral displacement to the model's face was limited to a maximum of 1 m. Each model was sitting on a 30 cm high platform so that the face was clearly visible by all participants. Participants were allowed 20 min to conclude the drawing.

Data Analysis

Mirroring the approach used in Study 1, the artistic and profile portraits were compared for shape with a Procrustes analysis using the *shapes* package in R (Dryden & Mardia, 2016), and considering the same 12 landmarks of Study 1. Canonical variate analysis with parametric *t* test was performed on Procrustes residual coordinates to statistically test the difference between artistic and photographic profiles for shape. Mahalanobis distance and Procrustes distance were computed as parameters of the difference between the two mean shapes. An example of artistic profile with the morphometric landmarks highlighted is shown in Figure 6, whereas Figure 7 shows the additional landmarks for the pupil width assessment.

In the analyses for size, to normalize all profiles to a same scale all the morphometric measures were standardized to face height. The parameters of eye height, eye width, nasion-eye front edge, lip height, lip width were compared with paired *t* tests contrasting the indexes from the drawings with the matched indexes computed from the male or female model's photographic profile.

Results

Shape.

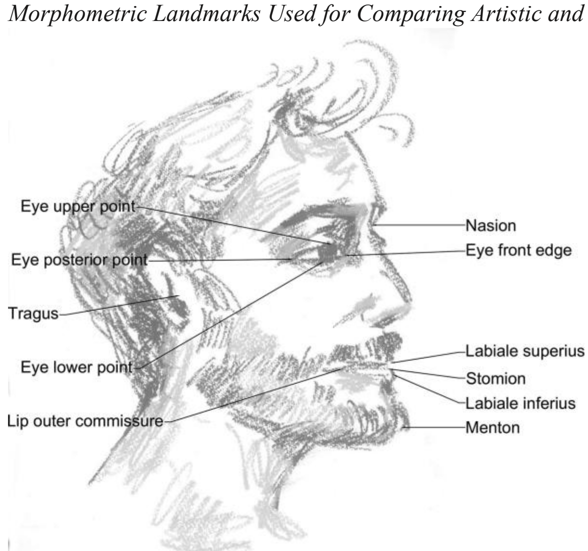
Mean shape for the eye region resulting from the Procrustes analysis is presented in Figure 8. The canonical variate analysis showed a significant difference between artistic and photographic profiles (Mahalanobis distance: 7.53*,* $p < .008$). Procrustes distance among groups was 0.09 ($p < .05$).

Mean shape for the lip region is shown in Figure 9. Mahalanobis distance between photographic and artistic profiles was 3.46 ($p < .001$). Procrustes distance among groups was 0.06 ($p < .66$).

Mean shape for the pupil region is shown in Figure 9. Mahlanobis distance among groups was 5.65 ($p < .008$). Procrustes distance among groups was 0.24 ($p < .05$).

Figure 6

Morphometric Landmarks Used for Comparing Artistic and Photographic Profiles in Study 2



Profiles—Size.

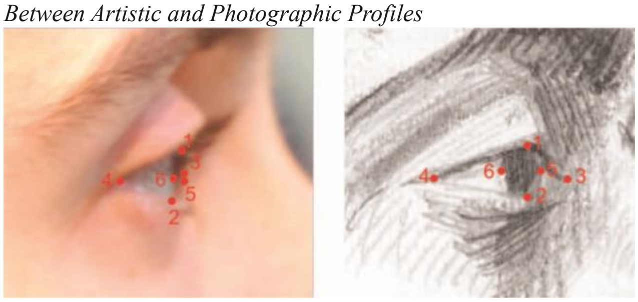
The results of the paired *t* tests comparing artistic and photographic profiles are reported in Table 2. Artistic profiles were characterized by a significant increase in the following indexes: eye width (106%), eye height (68%), lip width (59%), and pupil width/eye width (80%).

Discussion

The two studies confirmed, with two different methods, that the exaggeration of eye and lip sizes and a more frontal perspective of the eye, are systematic distortions introduced in artistic profiles. The paper extends on profiles, what found by Costa and Corazza (2006) who, with a similar methodology showed that, in fullfrontal artistic portraits, eye height, eye width, eye roundness, lip height, and lip roundness were significantly increased when compared to photographic full-frontal portraits.

Eyes and lips are, within the face, the most communicative and dynamic parts, and the reasons for the distortions in size and shape of eye and lips in artistic profiles could be functional to the creation of supernormal stimuli (Barrett, 2010; Ramachandran & Hirstein, 1999) that convey higher levels of attractiveness and expressiveness in comparison to eyes and lip that are morphometrically normal.

Figure 7
Landmarks Used for the Comparison of the Pupil Morphometry Between Artistic and Photographic Profiles



Note. See the online article for the color version of this figure.

Figure 8
Average Shapes After Procrustes Analysis of the Eye Region in Photographic and Artistic Profiles in Study 2

Note. See the online article for the color version of this figure.

Distortions in size in artistic works are often functional to the creation of supernormal stimuli (Barrett, 2010; Costa & Corazza, 2006). A supernormal stimulus is an exaggerated version of a stimulus to which there is an existing response tendency. The term was first introduced by Tinbergen (1951) together with Konrad Lorenz (Lorenz, 1942). For example, they found that birds tend to prefer brooding eggs that are larger than the one of their own species.

The origin of the augmented effects of a supernormal stimulus could be traced to the peak shift effect, as underlined by Ramachandran and Hirstein (1999) in their cognitive model of art. The peak shift effect is a process that emerges in discrimination learning when two stimuli differing along a single sensorial dimension or stimulus feature are presented, and only one is reinforced. After the learning discrimination is established, a test with new stimuli, not presented during the learning phase, will show a displacement of peak responding away from the reinforced stimulus and in a direction opposite to the stimulus that was not reinforced. For example, if a rat is taught to discriminate a square from a rectangle and is rewarded for the rectangle, it will soon learn to respond more frequently to the rectangle. Paradoxically, the rat's response will peak for a rectangle that is longer and skinnier to the one that was reinforced during the learning phase. This phenomenon shows that the animal is learning a rule (i.e., the *rectangularity* in this case) and not a prototype. According to Ramachandran and Hirstein (1999) artists convey an amplified version of the essence of a specific perceptual process. The amplified version will activate neural mechanism more powerfully than the original version. First evidences of the use of caricature and exaggerated contrast in artistic displays were those found by Cheyne et al. (2009) exam-

Figure 9 *Average Lip Shapes for Photographic and Artistic Profiles in Study 2*

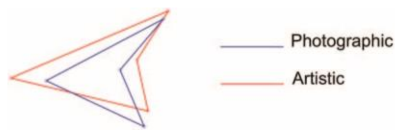


Table 2
Morphometric Indexes in Artistic Profiles and Photographic Controls. All Indexes, With the Exception of Pupil Width, Were Standardized for Face Height (Nasion-Menton Distance)

Facial feature	Artistic	Photographic	*t*	*p*	*Cohens' d*
Eye width	0.180 (0.04)	0.087 (0.01)	6.72	.001	3.72
Eye height	0.101 (0.03)	0.06 (0.02)	5.57	.001	1.64
Nasion—Eye front	0.134 (0.04)	0.133 (0.01)	.04	n.s.	
Lip width	0.156 (0.03)	0.098 (0.02)	4.61	.001	2.32
Lip height	0.128 (0.05)	0.136 (0.03)	1.27	n.s.	
Pupil/eye width	0.365 (0.21)	0.202 (0.05)	3.21	.007	1.25

ining Paleolithic cave paintings of horses and bisons. The distortions exaggerated the distinctive features of these two animals, leading the authors to conclude that the Paleolithic images represented an implicit bias of the mode of categorization of modern humans. In this perspective, the tendency to exaggerate eye size could be aimed to increase the attractiveness of the depicted person. Indeed, drawings or photographs of faces with larger eyes are considered more attractive than faces with smaller eyes by adults. Remarkably, this is true across faces of different age, sex, and race (Horvath et al., 1987; Keating, 1985; McArthur & Apatow, 1983; McArthur & Berry, 1987; Sternglanz et al., 1977). Geldart et al. (1999), manipulated face's eye size of drawing and color photographs and examined the effects on adults' aesthetic ratings and 5-month-olds' looking times. Both eye length and height were manipulated. The results showed that adults rated the faces with larger eyes as more attractive than the faces with smaller eyes. Infants looked longer at the faces with larger eyes but only with photographs. Another indirect evidence of the link between eye size and attractiveness was offered by Jones et al. (2018) who measured the apparent size of facial features in controlled photographs of faces with and without makeup and found that that eyes and eyebrows appeared larger with makeup than without. In all these previous studies, the eyes and the face were presented in full-frontal perspective.

The leading role of the eyes in portrait visual processing was also confirmed considering the centering eye phenomenon in portraits. Tyler (1998), examining a historical corpus of artistic portraits and self-portraits observed that the major part of them had one eye closely positioned to the horizontal center line. The result was confirmed also analyzing photographic selfies posted on *Instagram* from six world cities (Bruno et al., 2019). Furthermore, an examination of the eye-movement literature, starting from a classical study by Yarbus (1967), has highlighted that in face perception eye fixations are primarily focused on eyes and lips, with a main emphasis on eyes. Quinn and Tanaka (2009) have shown that also infants 3- to 7-month-olds tend to visually explore more the higher part of the face, and to fixate for longer time a version of the face with enlarged eyes. The preference for the eye region when looking at faces was also demonstrated by Iskra and Gabrijelcˇicˇ Tomc (2016) by asking adults to watch faces of different age. Considering a 4 s presentation, the eyes were observed for the 52.7% of the time, the mouth the 15.5% and the nose the 10.8%. The crucial role of the eye region in the correct identification of facial stimuli has been repeatedly demonstrated (Butler et al., 2010; Itier et al., 2007; Vinette et al., 2004).

Besides attractiveness, eye size increases the babyish appearance and the expressiveness of the face (Cunningham, 1986; Cunningham et al., 1995; Hildebrandt & Fitzgerald, 1979; Maier et al., 1984; McArthur & Apatow, 1983). In this light, the exaggeration found in art is further enhanced in stimuli specifically designed for children as cartoon characters, as noticed by EiblEibesfeldt (1989). The pupil size in artistic portraits was increased by a factor of 10.58% in Study 1 and by a factor of 80.69% in Study 2. Different studies have shown that the amygdala is strongly involved in the identification of pupil size modulations (Amemiya & Ohtomo, 2012; Demos et al., 2008; Harrison et al., 2006), and many behavioral studies have shown a positive correlation between pupil size and attractiveness (Bull & Shead, 1979; Hess, 1965, 1975; Stass & Willis, 1967; Tomlinson et al., 1978). The increase of the pupil size, together with the elongation of the eye shape, rendered the eye in a more three-quarter perspective. Since the three-quarter view leads to an advantage in face recognition over full face and profile (Fagan, 1979; Krouse, 1981; Logie et al., 1987; Perrett et al., 1985), it could be suggested that artists, "frontalizing" the eye, which is the most important part of the face, tend to facilitate face processing and encoding.

The modifications that interested the lips were coherent with those involving the eye. There was a significant change in lip shape toward a more elongated gestalt, and there was a significant change in size in which height (Study 1) and width (Study 1 and 2) were significantly increased. The increase in lip size is consistent with the results found by Costa and Corazza (2006) in fullfrontal portraits, whereas the elongation in shape could be interpreted as a rendering of the lips in three-quarter perspective, increasing their perceptual relevance.

The analysis of the historical corpus of artistic profiles showed a significant although moderate bias for left profiles outnumbering right profiles. This result extends on profiles the "cheek bias," already shown for three-quarter portraits (Conesa et al., 1995; Gordon, 1974; Lindell, 2013; McManus & Humphrey, 1973; Nicholls et al., 1999, 2002; Powell & Schirillo, 2009).

Future investigations should directly test the hypotheses of supernormalization and the link between supernormalization and increased attractiveness in artistic portraits using digital face warping techniques. In this perspective, reducing the shape or/and size distortion in eye and lips, matching them to normomorphic standards, should result in lower artistic value and attractiveness rating by observers. Similarly, the introduction of a distortion factor in eye and lips shape and size in photographic portraits, in a direction congruent with the results highlighted in this study, should lead to increased artistic value and attractiveness.

Putting together the data of Costa and Corazza (2006) with the data presented in this study, we can conclude that throughout the history of art painters have tended to overemphasize the most salient features for face perception and communication, such as eyes and lips. Additionally, in the case of profiles, eyes and lip shapes have been systematically modified toward a more frontal perspective. The investigation of systematic distortions operated by artists in the process of rendering "reality" into artistic products could shed light on the very nature of artistic expression, unveiling basic mechanisms for aesthetic perception.

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