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Eye-centering in portraits: Reply to McManus and Thomas

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Abstract. McManus and Thomas air some important issues in relation to the hypothesis of eye-centering in portraits, but many of them were already addressed in the original publication of Tyler (1998 *Nature* **392** 877). The statistical simulation offered by these authors does not have appropriate assumptions to match the properties of the observed distributions in historical portraiture. Further analysis of the two-dimensional form of the distribution strongly supports the hypothesis, as does an independent experiment of student's placements of drawn heads when blind to the hypothesis.

Eight years after its publication, McManus and Thomas offer a re-evaluation of the eye-centering tendency in portraits through the history of art (Tyler 1998a). The points that they raise are certainly worth consideration, but some were addressed in the original study. Other issues may be addressed with an analysis of the two-dimensional distribution of all eye positions in portraits. I also report an independent experiment of active head placements by a group of students who were blind to the hypothesis, which is a more direct test than the passive judgment between two preselected eye positions offered in the critique. But I first take up the point that there have been very few citations of the original publication.

It is noteworthy that the influence of an article in this sphere of analysis is not necessarily reflected in its number of citations. For example, the issue that almost always comes up in connection with the eye-centering is the way the eyes seem to follow the viewer in certain portraits, published by William Wollaston in the *Philosophical Transactions of the Royal Society of London* in 1824. This seminal paper has, however, been cited by only one scientific publication despite the passage of nearly two centuries. In terms of popular press, on the other hand, the original article (Tyler 1998a) was cited by literally hundreds of newspapers from Japan to Bulgaria, and numerous popular scientific magazines such as *Discover, New Scientist*, *Der Stern*, *Pour la Science*, etc, as well as several textbooks on perception. On a broader scope, the eye-centering ideas played a key role in two full-length books of broad scientific appeal: *Math and the Mona Lisa* by Bulent Atalay (2004) and *The Accelerating Universe: Infinite Expansion, the Cosmological Constant and the Beauty of the Cosmos* by Mario Livio (2000).

The critique treats us to a tutorial on statistics, pointing out that the 95% interval covers 21.8% or over one fifth of the entire picture width for the measured distribution. Let us not forget, however, that the 2/3rd confidence interval on the centering is less than 10% of the picture width, a remarkable constraint in an operational domain where the main expressed rule is to avoid symmetry. Despite McManus and Thomas's strong comments, the illustrations they cite are entirely representative of the Gaussian distribution with $\sigma = 5.6\%$ of picture width. The narrowness of this distribution when there is no specific task may be compared with performance when placement accuracy was the explicit goal. Igel and Harvey (1991) found that the accuracy of placement of each of several dots in a square (from immediate memory) was itself of the order of 5%, and thus the centered-eye placement in historical portraits is as accurate as optimal psychophysical performance.

In questioning the lack of references to eye-centering in the literature, McManus and Thomas cite Charles Saumarez Smith, then director of the National Portrait Gallery in London, as implying in the BBC interview that artistic decentering of the head is likely to result in one eye falling on the center line (and that a neuroscientist from San Francisco was unlikely to have worthwhile information to add the the question). Dr Saumarez Smith later apologized to me for this remark, saying that it was made in a cell-phone call in a train carriage, and that he had had no chance to read my paper before making his remarks. After shutting off the phone, he discussed the issue with his traveling companion, English portraitist Humphrey Ocean, who said that he was well aware of the potency of this centered eye location and frequently made use of it in his own portraits.

In their account of the original analysis, McManus and Thomas do not mention that it contains a thorough consideration of the alternative hypothesis that the eye-centering is simply a by-product of a tendency to center the head, combined with a random scatter of head turns around this point. This is the assumption underlying the MonteCarlo analysis that they offer in rebuttal. The data for the evaluation of this alternative hypothesis are reproduced in figure 1.

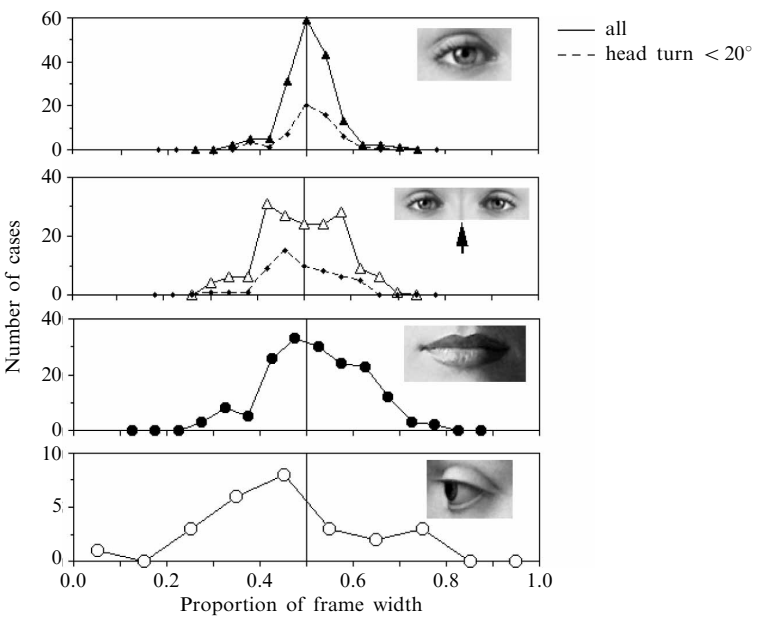

Figure 1. Distributions for several parameters of the portraits in the sample from 265 different artists over the past 600 years. The full curves show the distributions for, respectively, the most centered eye, the facial midpoint, the mouth, and the eye in portraits where only one eye was visible. The dashed curves show the first two distributions for cases in which the head turn was less than 20% (estimated from the offset between the nose tip and midpoint between the eyes).

Comparison of these results with their simulations makes it clear that McManus and Thomas did not choose conditions for their simulation that reproduced the pattern of data in the real portraits. The open triangle curve (figure 1) shows that the distribution of the facial midpoint is clearly (and statistically significantly) biphasic. The alternative hypothesis is that the head locations and head turns both have Gaussian distributions, and hence their joint distribution would also be Gaussian. The eye-centering hypothesis is that the head locations and turns are not independent but are jointly arranged to center one eye in a significant number of cases, and hence that the distribution of the facial midpoint should be biphasic, as was observed in the empirical

data. Similarly, the centering of the mouth is another measure of the hypothesis that the artists were centering the head rather than one eye, since the dual hypothesis of head-centering with random jitter should also be reflected in the mouth location. The mouth distribution is more than twice as wide as that for the most-centered eye (figure 1, filled circles), again a statistically significant difference, making it clear that the combination of head locations and turns does not generate the tight distribution that is implied by the Monte Carlo simulation. (The description of the nose jitter does not seem consistent with a standard deviation variously specified as 3% and 6.1% of picture width, but neither would increase the predicted mouth spread by a factor of two.)

Conversely, if the head were being centered as proposed by McManus and Thomas, the subset of portraits in which the head is facing frontally should itself show a bimodal distribution (since the two eyes should be on either side of the center line). Such portraits were selected as those with a head turn less than 20° on the basis of the nose angle (dashed curve in top panel, figure 1). This distribution is clearly just as narrow and as centered as the full distribution for the most-centered eye, validating that it is the eye that is centered in portraits (rather than the mouth, the face, or the head). The statistics offered by McMahon and Thomas fail to account for the empirical data in these two critical respects, as was made clear in the original publication. (Note that neither they nor I were able to find a way to measure the head position directly, its boundary being obscured by the hair, headwear, and shading in a large proportion of cases.)

Conversely, it is a pleasure to read that the larger sample of paintings used by McManus and Thomas validates the narrow spread of the most-centered eye in the portraits, providing a distribution even narrower than in the original paper. Moreover, it even confirms the bimodality of the facial midpoint distribution. Analysis of individual artists provides even stronger support of the hypothesis, revealing that artists such as Velazquez, Rembrandt, and Titian conform to the principle with σs of less than 4% of picture width, as does the full sample of portraits from the 16th through 18th centuries. The observation that more modern artists have looser distributions is hardly surprising, given the increasing pressure on artists to break convention and "épater les bourgeois". Indeed, it is to be expected that, if there is a 'rule' for conventional portraits, painters of the past century or so would have striven to violate it as they explored multifarious modes of expression. The correlation of head size with the progression of time noted by McManus and Thomas is thus one example of this exploration.

In their discussion they make the statement that "however, [a centered distribution] would also be true of any set of objects placed at random within a frame". This claim is hard to understand, since the distribution would have a σ of 42% if it were a truly random distribution (rather than the 5% that they measured). Perhaps this statement was intended to refer to the Monte Carlo simulation, which was engineered to match the empirical distribution of the eyes, but it does not appear to be applicable in the form stated.

The claims about the scattergram of their figure 4 are hard to evaluate. The plotting of the points the scattergram of their figure 4 is so dense that one cannot assess the characteristics of the central distribution by eye. Most of the claims about this distribution appear to be based on a small sample of outliers. McManus and Thomas have not demonstrated that, if it were plotted as a three-dimensional graph with the height quantified, it would show the same centered distribution of the most central eye as was found in the cited scatterplot from Tyler (1998b), reproduced here as figure 2.

The argument against an unconscious centering principle based on the failure to exhibit a 'pseudoneglect' bias to a leftward placement is interesting, but appears flawed in two respects. One is that the studies that support the pseudoneglect bias were based on line bisection tasks, which are not necessarily comparable to point placement within a rectangular frame (since the rectangle has corners that define diagonals that, maybe,

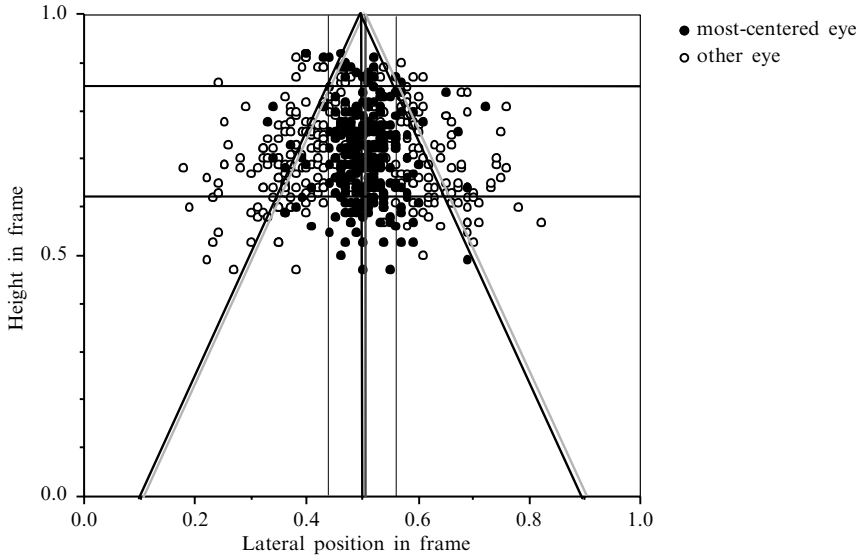

Figure 2. Two-dimensional positions of eyes in single-figure studies from 282 different artists over the past 600 years. The figure studies were selected according to the same principles as the portraits of figure 1, except that all figure lengths were included. The proportions of all paintings were normalized for inclusion in this figure, so that the positions are shown in terms of proportion to each frame dimension for the particular painting, regardless of its actual aspect ratio. The most-centered eye is shown by filled symbols, the other eye by open symbols. Except for a sparse fringe of less-centered positions, the most-centered eyes are clustered around the center vertical, forming an arrowhead pattern (colored lines) of the scaled centering of one eye on the center vertical rather than the inverted V-shape expected on the head-centering principle espoused by McManus and Thomas. The horizontal lines represent the Golden Section height of 0.618 and the iterated subdivision of the upper zone in the same ratio, as fiducials for the range of eye heights. The thin vertical lines are $\pm 1\sigma$.

provide extra reference structures). The second is that the experimental tasks were performed under explicit localization instructions, and may therefore have been drawing from a different state of neural organization than that of the portraitist at work. The portraitists' job was to paint the most compelling portrait of their sitters, not to estimate the location of the eye in the frame and attempt to center it.

An interesting exercise that is much closer to the portraitists' state of mind was conducted by Donna Gebhardt (personal communication) in a teenagers' art class in a high school in State College, Pennsylvania. She placed the images in figure 3a on an overhead projector and asked the students to choose one figure, draw it as quickly as possible, and turn the paper face down. The students did not have any information about the nature of the experiment and no other instructions were given. The distribution of eye positions was then measured and entered into a spreadsheet. The result, reproduced in figure 3b, shows that, in this free-expression format, the students adhered tightly to the eye-centering principle in the large majority of cases. This is a remarkable experimental validation of the eye-centering principle even in inexperienced draftspeople. There is a small bias in the distribution, which has a larger tail on the left side than on the right side that could be attributed to pseudoneglect, but the narrow centered peak retains the centered concept. It seems that the overall distribution could be made up of two components, a centered peak and a broader 'foothill' shifted by pseudoneglect, but a larger study would be required to validate such a hypothesis.

The results of figure 3 go some way to countering the inconclusive results of the experiment on viewer preferences reported by McManus and Thomas. While it is appreciated that they have taken the step to test the hypothesis experimentally, it is important

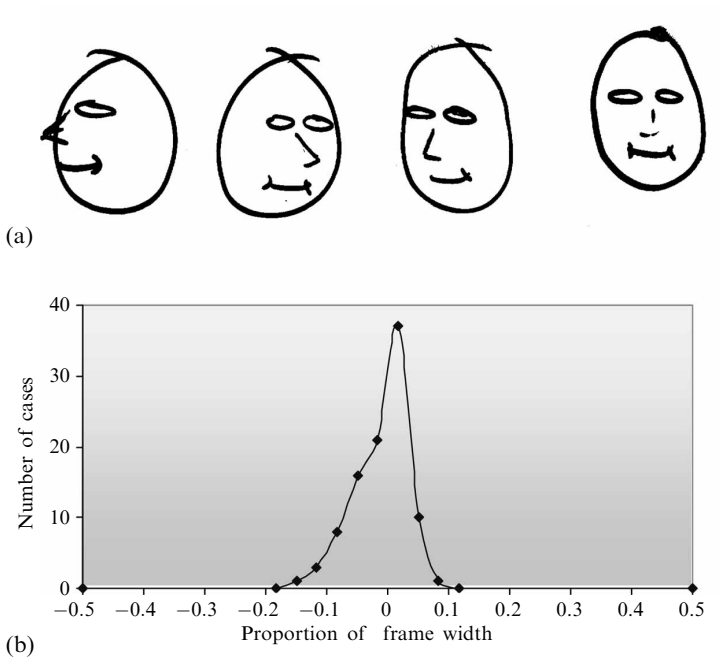

Figure 3. Histogram of most-centered eye positions in 93 high-school sketches.

to note that the experiment did not support either the eye-centering or the head-centering hypotheses. This non-significant result indicates that the viewers were not measurably sensitive to the range of shifts employed in the study. While this result does not support the positional analysis, it is possible that the choices made by artists who spend their lives painting portraits may be far more sensitive than those of casual observers. The result from the students suggests another possibility—that the operation of composing the portrait may bring more factors to bear than the judgment of preference during passive viewing.

Finally, the interpretation offered by McManus and Thomas that the eye-centering distributions should be expected to narrow over time represents a simplistic view of human nature. My original discussion (Tyler 1998a) made it clear that I did not regard the operation of an aesthetic principle as any kind of a constraint on artistic taste or artists' practice. It is a fact of human (indeed, biological) nature that abundance breeds variety. The more options that are available, the more types, models, and species are found. This is equally true of food, clothes, vehicles, and television programs. Why not, then, of portraiture? What is more remarkable, I would say, is that in an era of portrait abundance like the 18th century (relative to, say, several centuries earlier), the eye remained centered to a σ of less than 4% of the picture width. Perhaps it was common workshop practice to aim for this placement, but records of any such advice do not seem to have come down to us. Sir Joshua Reynolds, for example, painted over 2000 portraits that extensively exemplify the eye-centering principle, and gave a series of lectures as the first president of the Royal Academy (Reynolds 1769), but does not mention anything about the idea of centering eyes in portraits. On the contrary, he is one of the many art commentators who emphasize the importance of *variety* in composition. He explains that the portraitist is instructed

> "that his composition and his attitudes must be contrasting, that he must turn the head contrary to the position of the body in order to produce grace and animation, that his outline must be undulating and swelling, to produce grandeur, and that the [viewer's] eye must be gratified with a variety of colours." (Reynolds 1769; Eighth Discourse)

These assertions amount to the classical precept that good composition requires diversity and the avoidance of rigid symmetry. He amplifies this distaste later in the Eighth Discourse:

> "It is given as a rule by Du Fresnoy that *the principal figure of a subject must appear in the midst of the picture, under the principal light, to distinguish it from the rest*. A painter who should think himself obliged secretly to follow this rule would encumber himself with needless difficulties. ... there is no necessity that the principal light should fall on the principal figure, or that the principal figure should be in the middle of the picture. ... So far is this rule from being indispensable that it is very seldom practiced." (Reynolds 1769)

Reynolds is here talking of multifigure compositions, but we can be sure that he intends the rule *against* centering the principal figure to apply equally to the elements of a single portrait composition. It is, indeed, typical of portraits for almost everything but the eye to have a balanced asymmetry, but again, it is the eye that is the exception to this asymmetry rule. This diversity may be reconciled with the eye-centering principle by the (informal) observation that the eye in portraits often acts as a symmetric fulcrum around which the compositional asymmetry swirls. This opposition may be seen as an example of the compositional contrasts of which Sir Joshua speaks, but he does not make this particular opposition explicit, leaving us uncertain whether he was aware of the tendency to center one eye despite the extent to which it characterizes his portrait compositions.

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