18 October 1998

The bio/logic of facial geometry

David A. Meyer* and Melanie W Quong†

*Project in Geometry and Physics, Department of Mathematics 0112
†Department of Biology 0366
University of California/San Diego, La Jolla, CA 92093, U.S.A.
dmeyer@chonji.ucsd.edu, quong@biomail.ucsd.edu

The concluding paragraph of the letter by Perret, *et al.*[1], which remarks that "preferences would encourage a youthful, neotonous appearance in the species generally", conflicts with the semantics—of 'masculine' and 'feminine'—used to construct the argument presented. Brennan's caricatures of Ronald Reagan[2]—reproduced in the *News and Views* gloss by Enquist and Ghirlanda[3]—hint at this conflict. In this note we examine the logic of this conflicted argument and suggest that biological data might strengthen Perret, *et al.*'s inferences.

We characterize the argument as semantic because 'masculine' and 'feminine' are used to refer to three distinct aspects of faces: the extent to which they reflect the "action of sex hormones during growth", how they are perceived by the subjects queried, and their position on the 'shape continuum' defined by the 174 feature points measured[1]. For brevity, let us refer to these three uses as biological, psychological and geometrical. The "surprising"[3] nature of the observations rests on the unexamined identification of geometrical and biological or psychological sexuality: The hypothesis that hormone-dependent sexual characteristics most importantly[4] advertise pathogen-resistance[5] because the immunosupressive consequences of testosterone and estrogen production[6] are Zahavian handicaps[7] leads Perret, *et al.* to expect their experimental subjects to prefer masculinized (feminized) male (female) faces[1]. *But this expectation evaporates if geometrical differs from biological sexuality for faces.*

In fact, when their observations conflict with this expectation, Perret, *et al.* acknowledge that subjects' preferences "may reflect the effects of masculinity on perceived age"[1]. That is, geometrical masculinity may correlate strongly with psychological and/or biological age so that geometrically feminized faces signal youthfullness more than biological femininity. If this be the case, Perret, *et al.*'s observations would rather provide evidence for direct selection (for facial features signalling youthfulness) than against indirect selection (for secondary sexual characteristics signalling parasite resistance)[8].

That geometrical extrapolation may signal characteristics other than those from which they are constructed should come as no surprise. The choice of initial features can be almost arbitrary and produce unintended signals: Fig. 1 shows an extrapolation along a pongid to hominid skull subspace[9] inspired by a high school biology assignment comparing and contrasting gorilla, Paranthropus, Neanderthal and human skulls[10]. For our present purposes, note the delicate 'feminine' jaw and round 'neotonous' head. Perret, *et al.*'s subjects might even be interpreted as expressing a preference for 'hominized' over 'pongidized' faces.

To limit such spurious signals, we suggest geometrical interpolation be used only to supplement biological data in constructing test faces: For example, to determine how subjects respond to age, one might prepare averaged male and female faces from sets of 15 year old faces, from sets of 20 year old faces, *etc.* Ideally one would prepare averaged faces for a continuum of ages, but geometrical interpolation between closely spaced averages should be almost equivalent to a purely biological construction. Subjects would then be queried for their responses on these new facial subspaces.

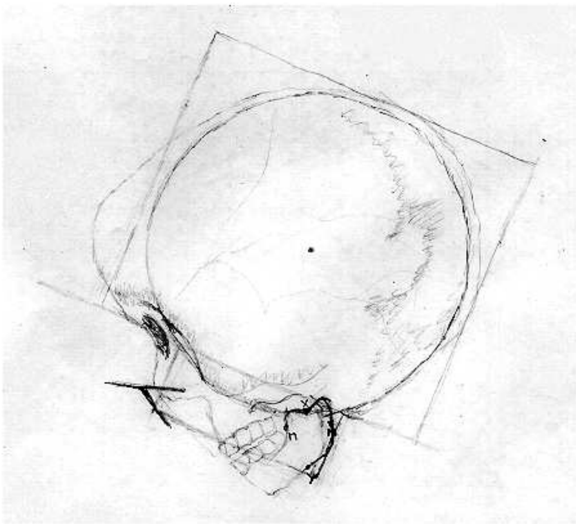

Figure 1. An extrapolation beyond human along a shape continuum defined by 8 feature points on gorilla, Paranthropus, Neanderthal and human skulls[9,10]. (Courtesy of Marilyn Pettit archives)

The analogous experiment for biological sexuality is more difficult, but still possible[11]: sex hormone titers should be measured during development and averages prepared from sets of faces grouped according to time integrated hormone amounts. Again, to reduce the data collection one could interpolate between some reasonable number of averaged faces. The resulting shape continua would, by construction, reflect biological sexuality rather than the geometrical version used by Perret, *et al.*[1]. Furthermore, the biological age and sexuality shape continua could be compared to determine the correlation between the two signals.

In such experiments the biological determinant of the signal would be unambiguous, isolating the psychological component of subjects' reactions to faces which Perret, *et al.* have examined in their letter[1], and supporting an argument considerably less dependent on questionable semantics.

References

1. D. I. Perret, K. J. Lee, I. Penton-Voak, D. Rowland, S. Yoshikawa, D. M. Burt, S. P. Henzil, D. L. Castles and S. Akamatsu, "Effects of sexual dimorphism on facial attractiveness", *Nature* **394** (1998) 884–887.
2. S. E. Brennan, "The caricature generator", *Leonardo* **18** (1985) 170–178.
3. M. Enquist and S. Ghirlanda, "The secrets of faces", *Nature* **394** (1998) 826–827.
4. I. Folstad and A. J. Karter, "Parasites, bright males, and the immunocompetence handicap", *Amer. Nat.* **139** (1992) 603–622;
   C. Wedekind, "Detailed information about parasites revealed by sexual ornamentation", *Proc. Roy. Soc. Lond. B* **247** (1992) 169–174.

5. W. D. Hamilton and M. Zuk, "Heritable true fitness and bright birds: a role for parasites?", *Science* **218** (1982) 384–387.
6. C. J. Grossman, "Interactions between the gonadal steroids and the immune system", *Science* **227** (1985) 257–261;
   J. Alexander and W. H. Stimson, "Sex hormones and the course of parasitic infection", *Parasitol. Today* **4** (1988) 189–193.
7. A. Zahavi, "Mate selection—a selection for a handicap", *J. Theor. Biol.* **53** (1975) 205–214.
8. M. Kirkpatrick and M. J. Ryan, "The evolution of mating preferences and the paradox of the lek", *Nature* **350** (1991) 33–38.
9. D. A. Meyer, unpublished (1973). The subspace was constructed by hand using a procedure similar to, although considerably simpler than (using only 8 skull features), the one followed by Perret, *et al.*[1].
10. *The Human Species: Evolution*, a student module (Towson, MD: Board of Education of Baltimore County 1973).
11. R. Thornhill and S. W. Gangestad, "Human facial beauty: averageness, symmetry and parasite resistance", *Hum. Nature* **4** (1993) 237–269.