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BIOMETRIC AESTHETICS

Towards a Critical Theory of the Biometric Body

The undulating pink surfaces of Zach Blas's "Fag Face Masks" (FIG. 1), part of his *Facial Weaponization Suite*, confront the viewer with a grotesque and uncanny vision of the human face. The masks are visualizations constructed using Kinect sensors and 3D modelling software that combine the biometric facial data of multiple queer men, with Blas using these to rework and challenge the dominant biometric constitution of bodies and subjects. Initially conceived as a response to police use of nineteenth century anti-masking laws against Occupy protesters in New York in 2011, the project functions in several registers: it "allows participants to simultaneously wear the faces of many,"[1] thus remaking identity as a collective rather than an individualizing project; it spoofs the claim of some biometric scientists to be able to read sexuality from faces (his series of black masks also parodies biometric misrecognition of darker skin tones); and, when worn, the masks render the wearer unidentifiable to biometric face recognition systems. Drawing on Jack Halberstam's notion of "queer failure," Blas aims for a "disorderly and uncompromising (anti-)aesthetics and (anti-)politics"[2] that draws its power from the systematic and deliberate misrecognition produced by a queer embodied politics. Blas thus contends that "*Facial Weaponization Suite* invests in illegibility, against standardization and state-based forms of inclusion and exclusion, and fights for the desire to escape into something else beyond legal recognition and identification. Such is the queer practice of defacement, which occurs when one's face is made amorphous, weird, eccentric, and otherworldly with a group."[3]

Blas's masks visualize the failure at the heart of systems of biometric identification, but, in repurposing biometric technologies themselves, they go deeper, making visible what I argue is the aesthetic dimension (the aesthetic core, even) that runs through all biometric science. Biometric technologies do not merely register existing bodies and faces, Blas's masks suggest—they actively produce meaning through an amalgam of scientific and aesthetic practices. This aesthetico-scientific conjuncture is perhaps most evident when biometric techniques are used in digital film animation or in enabling amusing Snapchat filters, but I argue that it shapes every stage of biometric identification. Face recognition systems are made up of a variety of elements: a sensor that reads faces; a feature extractor that generates a digital representation of the sensor data; a matcher that compares the scanned face with a database of stored templates; and often a decision module linked to a particular application (e.g., a biometric airport scanner designed to identify potential threats). At their heart, they are probabilistic pattern recognition systems driven by algorithmic processing and, increasingly, "deep learning"—trained using large datasets of photographs—and with success measured in terms of processing speed and error rates (i.e., of how often people are mis-identified as

FIG. 1 Zach Blas, *Facial Weaponization Suite: Fag Face Mask* - October 20, 2012, Los Angeles, CA, vacuum formed plastic masks, photo by Christopher O'Leary, image courtesy of the artist.

someone else, or not identified as themselves).[4] However, Blas's work demonstrates that, by tweaking algorithms, these systems can produce radically different results thereby denaturalizing the ideologies of identity that underlie biometric science. The intimate relationships between biometrics and the aesthetics of the body that infuse all stages of biometric identification is the locus of this paper.

The aesthetic dimension of biometric science is perhaps most visible if we consider its historical roots. Whether deliberately or not, Blas's masks echo the nineteenth century composite photographs that Francis Galton used in developing his eugenic research, a link that foregrounds the danger identified by Armand Mattelart: "with the excessive use of biometrics, the old demon of eugenic formatting has resurfaced in modern form."[5] I thus begin my discussion below with a return to the aesthetico-scientific practices of early eugenics that produced bodies not only as *detectable* but also, following Fae Brauer's historical analysis of art and eugenics, as "*delectable*." In constituting bodies structured through dynamics of racism, gender, class, disability, and sexuality, she argues that "both art and eugenics may be then perceived as having functioned as mutually reinforcing mechanisms disciplining the body and exposing it to the collective eye of surveillance."[6] Photography played a key role in this respect, especially in late nineteenth century sciences of the body that valourized the statistically-generated "average man" and inspired the journal, *Biometrika*, founded in 1901 by Galton and Karl Pearson. In these practices, as Allan Sekula notes,[7] the mathematical symmetry of binomial distribution (the bell curve) was increasingly seen as an expression of beauty, health, normality, and morality.

Photography is a central medium in contemporary biometrics as well, which is built on systems of machine learning and computer vision that process databases of photographs. I thus turn to contemporary biometric textbooks and specialist scientific literature in order to trace the ways in which face recognition systems function. My argument suggests that there are continuities with earlier practices, although important shifts have also taken place. Contemporary biometric scientists frequently acknowledge Galton as a forerunner, for example, but they rarely discuss his role in eugenics and scientific racism. At one level, this is an inexcusable omission. But it is also true that the goals of contemporary biometric science are different, focusing on identification rather than the kind of social engineering we see in Galtonian projects of racial fitness. Nevertheless, contemporary biometric scientists share the nineteenth century desire to render bodies legible, to remake them as data; this raises a host of uncomfortable questions, not least around how biometric science encodes normative conceptions of bodies, with gender and race a particular focus in what follows. Awareness of these potential problems is growing amongst biometrics researchers, but I argue that even projects like IBM's Diversity in Faces (DiF) initiative, which was designed to address some of the inequities built into biometric science, are unable to overcome fundamental aesthetico-scientific contradictions. In foregrounding the aesthetic dimension, we can gain the purchase necessary to spur a critical reconceptualization of biometric face recognition as inextricably linked to broader apparatuses of repressive surveillance. This is not a call for biometric reform, in other words, but a challenge to the fundamental aesthetico-scientific bases of the biometric project.

BUILDING A BIOMETRIC AESTHETIC

Working in the late nineteenth and early twentieth centuries, Alphonse Bertillon pioneered the use of photography and anthropometric measurement to identify "criminals." His famous photographic arrays of noses, ears, chins, and other facial elements are, in many ways, precursors to contemporary biometrics, most notably in isolating specific quantifiable bodily features to facilitate that process

FIG. 2 Physiognomic features for use in the identification of criminals by the Paris police force. Photograph, 1900/1920, of a photographic collage by Alphonse Bertillon, 1901/1914.

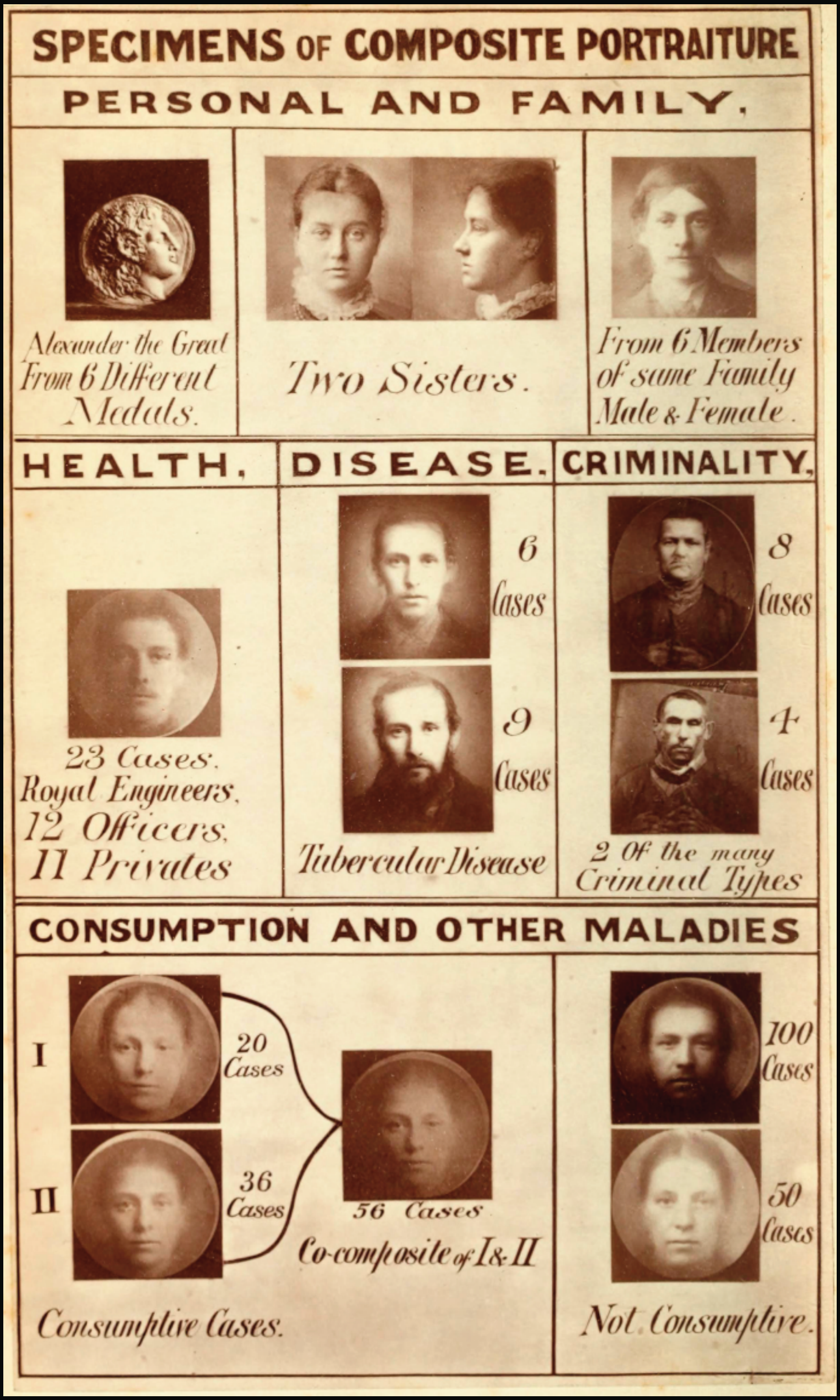

FIG. 3 Specimens of composite portraiture. From Francis Galton, *Inquiries into Human Faculty and its Development* (London: Macmillan and Co., 1883).

(FIG. 2). Bertillon's approach exemplified the "mechanical objectivity" that, in Lorraine Daston's and Peter Galison's account, came to dominate the visual practices of nineteenth century science.[8] Photography in this context was both a tool of and a model for scientific inquiry, its mechanical reproductions understood as guaranteeing a truth separate from the subjective status of the observer. This scientific photography can be read as aesthetic in Jacques Rancière's sense, generating a "distribution of the sensible" and a "delimitation of spaces and times, of the visible and the invisible, of speech and noise, that simultaneously determines the place and the stakes of politics as a form of experience."[9] In the case of biometrics and eugenics, it is the body whose contours and (in)visibilities are delimited, with Rancière's linking of the distribution of the sensible to police order particularly apt in relation to Bertillon's criminological innovations.

This myth of photographic objectivity retains a powerful hold today, even though, weighed down by the rapid proliferation of data, it quickly came under strain even in the nineteenth century. Indeed, Bertillon himself noted a number of the challenges to visual identification with which contemporary biometric scientists continue to grapple. Variable lighting and other environmental factors, he stressed, put powerful strains on photographic objectivity, making it impossible to extract truth from the proliferating data: "one has to be thoroughly familiar with human physiognomy to identify the same subject at different arrests from among many photographs.... Photography is hardly useful anymore and now serves only as a means of verification."[10] Partly as a response to this breakdown in meaning, however, Bertillon and others sought to rescue mechanical objectivity by bringing order to proliferating data through complex systems of classification and statistical analysis. As Sekula notes of the bureaucratic apparatus and practices that provided the scaffolding for these new forms of knowledge, "the central artifact of this system is not the camera but the filing cabinet."[11] The filing cabinets of today, we might say, are the databases and machine learning systems on which biometric technologies are built.

Scientific photography developed its own distinct aesthetic traditions, offering eugenicists like Francis Galton the possibility of apprehending and intervening in bodies in new ways, but this mechanical objectivity produced profound internal contradictions. These are especially evident in Galton's composite photography, which sought to find the "truth" of faces in their statistical visualization. Galton developed techniques for taking multiple short exposures of different faces, which, as the array shown here demonstrates, enable common facial characteristics to emerge clearly and "deviations" to fade into a ghostly blur (FIG. 3). These composites were intended to visualize statistical norms, the result representing "a perfect test of truth in all statistical conclusions."[12] For Galton, these composites avoided the excessively aestheticized quality of earlier scientific visualizations, but most importantly, as we see from the images included here, they allowed for the visualization of the various "types" (although not racial types in this instance) so central to eugenic thought. Here we come up against a methodological circularity, however: composite photographs were framed as raw material for the discovery and construction of racial and other taxonomies, but individuals whose images were layered to produce the composites were themselves selected on the basis of precisely the categories they were intended to make visible. As we shall see, this fundamental problem with typological categorization continues to plague systems of biometric identification.

Galton's 1878 article on composite photography in the journal, *Nature*, shows the extent to which, despite his critique of the excessively aesthetic nature of earlier scientific visualization, his method operated along the porous and unstable border between art and science. Composite portraits, he proclaimed, enabled a "mechanical precision," but that precision "represents the picture that would rise before the mind's eye of a man who had the gift of pictorial imagination in an exalted degree."[13] Photography occupies a strange role here, both corrective to and in fulfilment of the "exalted" promise of art. For Galton, aesthetic criteria in fact legitimate science:

> It will be observed that the features of the composites are much better looking than those of the components. The special villainous irregularities in the latter have disappeared and the common humanity that underlies them has prevailed… All composites are better looking than their components, because the averaged portrait of many persons is free from the irregularities that variously blemish the looks of each of them.[14]

Classical aesthetics, with its celebration of the symmetrical and smooth body, merges here with scientific practice; it is no surprise that we often find Greek sculpture prominently displayed in eugenic texts as ideals of "healthy" bodies, their firm contours embodying the humanity that, Galton implies, is marred by the villainous irregularities associated so often in eugenic thought with racialized difference, deviation from binary gender roles, disability, and other non-normative forms of embodiment.

BIOMETRICS, AUTOMATION, AND AESTHETICS

James Wayman's foreword to a recent undergraduate- and graduate-level introductory biometric textbook begins with a quote from the inaugural editorial statement to Galton's *Biometrika* in 1901, but does so in order to differentiate the contemporary meaning of "biometrics" from its predecessors. Studiously avoiding the term "eugenics," Wayman argues that "biometrics in this [contemporary] sense is not about understanding mass-phenomenon [*sic*] in the context of evolutionary biology, but about understanding the distinguishing characteristics of individual persons for the purpose of recognition."[15] Wayman is not wrong in noting that contemporary biometric science is no longer integrated with evolutionary biology but, as Kelly Gates stresses, that does not necessarily mean it has shed all vestiges of eugenic influence.[16] Continuities are evident, especially at the level of biometric applications, with areas of long-standing concern to eugenics like border security or policing precisely where biometric systems are implemented most extensively today. Often the historical continuities run deep, as with the punitive and algorithmically-driven systems, including biometric systems, that are increasingly being implemented to manage the poor and that, as Virginia Eubanks argues, draw deeply on the eugenic heritage.[17] It is also not possible to argue that the science itself is innocent of its application. Indeed, as the authors of the textbook introduced by Wayman themselves note: "the design of a biometric system completely hinges on the nature of the application in which the biometric system will be used eventually."[18]

Algorithmic and machine learning processes are at the heart of biometric systems and, as a number of critics have shown, enable biopolitical systems of control and reinforce dynamics of racism, gender, disability, and class.[19] What I want to focus on briefly here is how, as was the case with nineteenth and early twentieth century techniques like Galton's composites, these social dynamics are encoded in the basic aesthetico-scientific design of automated face recognition systems. Such automated systems first emerged in the 1980s with the development of the Eigenface technique, followed by other pattern recognition approaches designed to identify faces. The Eigenface approach worked by condensing the range of characteristics being computed, "demonstrat[ing] that a suitably aligned and normalized face image can be approximated with considerably fewer values."[20] As the biometric researchers Gregory Shakhnarovich and Baback Moghaddam emphasize, the goal of Eigenface and other biometric systems was, in other words, to reduce the density of data culled from faces and bodies, in particular by constructing shortcuts that take advantage of the statistical regularities that are generated by normative characteristics of faces. At one level, this builds on the fact that "much of the surface of a face is smooth and has regular texture," meaning that pixel-by-pixel analysis is not necessary, dramatically reducing demands on the system. Statistical regularities are also substantive: "the appearance of faces is highly constrained; for example, any frontal view of a face is roughly symmetrical, has eyes on the sides, nose in the middle, and so on. A vast proportion of the points in the image space does not represent physically possible faces."[21] While these claims may seem uncontroversial, this framing of purportedly normative characteristics is where a host of problems arise. Even the most general characteristics traced above are not universally valid, and the more detail we give to these normative models, the more the spectre of Galton's "villainous irregularities" and the nineteenth century equation of statistical norms with aesthetic and bodily norms returns.

The aesthetics of objectivity underlying contemporary biometric image-making and analysis is in some respects quite different from that of its nineteenth century precursors. Rather than mechanical objectivity, Daston and Galison argue that contemporary practices of scientific visualization turn on "haptic images" in which "nature merges with artifact." For them, haptic images are tools more than representations, "images in which the making is the seeing."[22] Stressing the key role played by automation, the artist and critic Trevor Paglen argues that with biometrics "we no longer look at images—images look at us."[23] Human vision is incidental to biometric vision, with machines processing data internally and communicating primarily with other machines. Paglen thus stresses that "Machine-machine systems are extraordinary intimate instruments of power that operate through an aesthetics and ideology of objectivity, but the categories they employ are designed to reify the forms of power that those systems are set up to serve."[24] We need a whole new conceptual framework to understand biometric systems like the DeepFace algorithm underlying Facebook's face recognition applications, he says; "if we want to understand the invisible world of machine-machine visual culture, we need to unlearn how to see like humans."[25]

Paglen's arguments are crucial to understanding biometric systems, but we need to be cautious in proclaiming a wholly new aesthetics of objectivity. Machine-machine systems are increasingly prevalent, but, as I will discuss later in relation to the construction and annotation of training datasets, they still rely on often rather crude human interventions. As importantly, the older model of mechanical objectivity retains a significant hold, with photographic realism and a naïve faith in the body as a stable locus of meaning still central to the "distribution of the sensible" characteristic of contemporary biometrics. Thus, mechanical objectivity co-exists, if uneasily at times, with the more open-ended and probabilistic nature of algorithmic processing and machine-machine interaction.

What is distinctive about automated processing systems, Luciana Parisi contends in *Contagious Architecture*, is that their semi-open architectures produce "a concrete culture, an aesthetic and a mode of thought, specific to the computational production of new probabilities."[26] "Aesthetics," she continues, "must… be understood to reside at the core of computational logic… it exposes contingency in programming, and the reality of chance in the calculation of probabilities."[27] This aesthetic core is especially evident in art (we saw this aspect in Blas's work), but it is also at the heart of the mathematical logic on which algorithmic systems are based:

> aesthetic computing relies on the idea that the shortest program used to calculate infinite complexity is the most eloquent expression of harmony and elegance in mathematics. To put it simply, aesthetics in computation, from this perspective, coincides not with notions of perception but with transcendental ideas of beauty, conceived as an ideal form and represented in geometric models of linearity and symmetry.[28]

Parisi stresses the novelty of these forms of automated processing, but while the mathematics may have evolved, we are perhaps not so distant here from Galton's evocation of classical aesthetic ideals of symmetry in his 1889 book, *Natural Inheritance*: "whenever a large sample of chaotic elements are taken in hand and marshalled in the order of their magnitude, an unsuspected and most beautiful form of regularity proves to have been latent all along."[29] What distinguishes contemporary biometrics from its precursors, then, is perhaps more importantly its automation and integration in systems of ubiquitous computing than any more fundamental change.[30] This is the world of Paglen's machine-machine communication and Blas's parodic interventions, but it is a world, as Blas contends, in which the design and training of biometric systems encode older aesthetic and embodied norms along with their various consequential social dimensions.

BIOMETRICS AND THE AESTHETICS OF THE BODY

Writing on the epistemology of biometrics in one of the few collections to bring biometric scientists and those in the social sciences and humanities together, Giampaolo Ghilardi and Flavio Keller argue that bodies are measurable, but, in some respects echoing Parisi's emphasis on the contingency at the heart of automated algorithmic processing, they stress that this does not imply that identity is fixed. Identity is complex, and "it is enough to say that it is a naïve error to consider it a static thing, it rather is a multidimensional reality that keeps changing, preserving its unity."[31] Biometric identification thus requires a "sort of continuous check-in"[32] that can track those identity changes over time. The embodied subject here is elusive, always threatening to dissolve if not kept in view. Not only does this argument suggest that the nineteenth century ideal of the body as stable and transparently accessible to scientific scrutiny has lost its grounding, it also legitimates an "always on" surveillance—a biometric demand for a constant stream of data that has, in turn, fundamentally shaped scientific practice.

The extent to which biometric scientists are quite aware of the fluidity of bodily identity is often downplayed in critical perspectives that stress their inscription of stable bodies. Indeed, it is the recognition of biometric bodies as fragmented and fractal that drives the science, their changing surfaces, angles, and textures requiring ever more sophisticated algorithms to interpret, especially when "in the wild," which is the term used to designate biometric systems deployed in uncontrolled environments. Crucially, however, these characteristics of the body (which in some respects, ironically, mirror the insights of intersectional analyses that foreground diversity and difference) are posed not

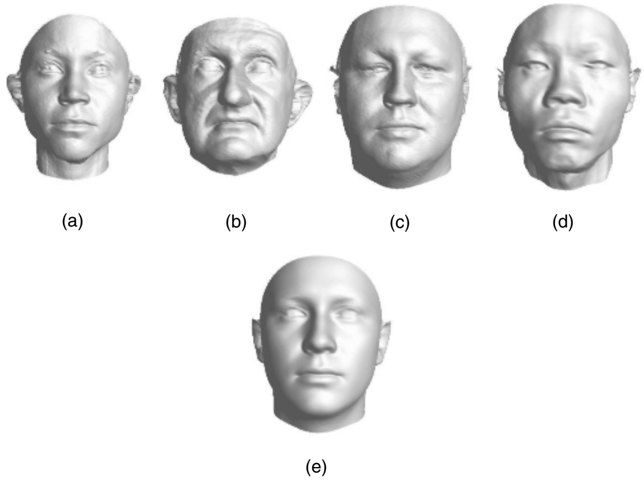

Figure 2.2. Examples of face meshes used for linear space representation. (a), (b), (c), and (d) are examples of laser-scanned face meshes from University of South Florida (USF) HumanID 3D database. (e) is the average of 100 faces in the USF HumanID 3D database.

Let $\mathbb{V}_i = (X_i, Y_i, Z_i)^T$, $i = 1, ..., n$, denote the vertices of a face mesh. Its geometry is represented by a vector

$$\mathcal{S} = (\mathbb{V}_1^T, ..., \mathbb{V}_n^T)^T = (X_1, Y_1, Z_1, ..., X_n, Y_n, Z_n)^T. \quad (2.2)$$

Suppose there are $m+1$ face meshes that are obtained by using laser scanner or some other means. Let $\mathcal{S}^j$ denote the geometry of the jth mesh, $j = 1, \ldots, m+1$. These faces generate a linear space of face geometries:

$$F = \left\{ \sum_{j=1}^{m+1} \alpha_j S^j : \sum_{j=1}^{m+1} \alpha_j = 1 \right\}. \quad (2.3)$$

Let $\mathcal{S}^0$ denote the average face geometry, that is, $\mathcal{S}^0 = \frac{1}{m+1} \sum_{j=1}^{m+1} \mathcal{S}^j$. Denote $\delta\mathcal{S}^j = \mathcal{S}^j - \mathcal{S}^0$, $j = 1, ..., m+1$. Note that these vectors are linearly dependent. We perform Principal Component Analysis on the vectors $\delta\mathcal{S}^1, ..., \delta\mathcal{S}^{m+1}$. Let $\sigma_1^2, ..., \sigma_m^2$ denote the eigenvalues with $\sigma_1^2 \geq \sigma_2^2 \geq \cdots \geq \sigma_m^2$. Let $\mathcal{M}^1, ..., \mathcal{M}^m$ denote the corresponding eigenvectors. Then any face $\mathcal{S} \in F$ can be represented

FIG. 4 From Zicheng Liu and Zhengyou Zhang, *Face Geometry and Appearance Modeling: Concepts and Applications* (Cambridge: Cambridge University Press, 2012), 22. Reprinted by permission from Cambridge University Press.

as social or political questions, but rather as purely technological problems to be overcome. It is here that the stable body returns to anchor the biometric project as this selection of laser-scanned face meshes from the HumanID 3D database demonstrates (FIG. 4). The top row of faces are visualizations of individual scans, while the smooth bottom face (another composite) was produced by averaging 100 such scans. Discussing these images, the biometric researchers Zicheng Liu and Zhengyou Zhang argue that "ideally one would like the captured images to be clean and have a good skin tone."[33] The composite image thus reflects a familiar classical scientific aesthetic of cleanliness and symmetry, an ideal that runs through the biometric literature, and explains why in airports and other security settings our bodies are positioned, posed, and lit in consistent ways. For all the recognition of the fractal and fluid nature of bodies, the classical aesthetic ideal retains its hold, marking the moment of "failure" that, as Shoshana Magnet stresses, is endemic to all probabilistic biometric systems. Overcoming endemic failure is the goal, but that failure is also not random. The "good skin tone" comment is but one instance where we can see the extent to which aesthetic judgement grounds normative conceptions of the body, and, as Magnet argues, leads to failures that reflect the differentiations of racist, misogynist, class-based, and ableist cultures.[34]

Gender identification in face recognition systems represents perhaps the clearest area in which these questions of error come together explicitly with aesthetic and bodily norms. Gender is a "soft" biometric marker, meaning that it is generally read from a range of characteristics that include hair or clothing as well as the dimensions of the face. None of these characteristics are universal or wholly stable, but with hair, for example, we can see clearly how building this into a biometric system as a shortcut facilitating data processing encodes aesthetic and gender norms, cementing a stable system of categorization based on a clearly differentiated two-gender system. In this context, error rates in part mark deviations from gendered norms. As the Gender Shades project has demonstrated, these error rates intersect with racist dynamics as well, with commercial face recognition systems displaying dramatically higher error rates when trying to identify people, and especially women, with darker skin tones (as low as less than 1% for light-skinned men, but up to 35% for darker-skinned women).[35] It is not always clear what is responsible for those errors as deep learning biometric systems are often opaque even to their designers, but one significant source is the training process. The DeepGender2 project, for example, which uses convolutional neural networks (CNNs) as the basis for a deep learning system that can recognize gender difference, shows how this skewing works in practice. It "learns" by surveying datasets of images, which means it encodes biases in those datasets, but it is also taught through a dialectical process of "reinforcement learning"[36] in which the designers "nudge" the system towards apparently scientifically pre-determined gender cues—in this case, the purported significance of the periocular region (the area around the eye). In other words, it learns through automated pattern recognition, but its findings are shaped both by the dataset from which it learns and by the nudges that direct it to the purported gendered locations on the face.

The article describing DeepGender2 uses photos of Daniel Craig and Anne Hathaway as exemplars of gendered faces, clearly demonstrating the profoundly binary notion of gender in operation here, as well as its skew towards white faces. The use of these famous figures also points to two other important elements that shape much biometric research: the reliance on celebrity faces, and the deployment of a notion of beauty combining both technical and aesthetic criteria. Automated facial beauty analysis is a subfield of biometric research that foregrounds these different dimensions.

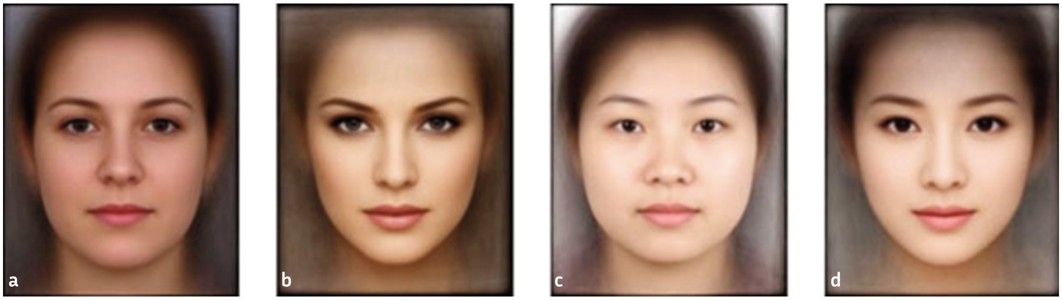

FIG 5. From David Zhang, Fangmei Chen, and Yong Xu, *Computer Models for Facial Beauty Analysis* (New York: Springer, 2016), 24. Reprinted/adapted by permission from Springer Nature Customer Service Centre GmbH: Springer. *Computer Models for Facial Beauty Analysis* by David Zhang, Fangmei Chen, and Yong Xu (2016), 24.

While this is a relatively marginal area of face recognition research, it is useful to look at as it makes clearly visible the inextricability of aesthetics, scientific practice, and normative conceptions of the body. Images of celebrities found in datasets like CelebA are widely used in biometric research precisely because they cement these links: celebrities are understood to embody normative characteristics of beauty and the body, and their photographs are more likely to be carefully posed and of high image quality.

Computer Models for Facial Beauty Analysis provides us with a good example of this area of research, presenting us with the Mona Lisa and a bust of queen Nefertiti as early exemplars of beauty, and then providing a histogram tracking the higher "attractiveness score" of celebrities as compared to "common" people.[37] Facial symmetry and averageness serve as markers of beauty (exemplified by Nicole Kidman), and in this case the links to eugenic thought are made explicit: the book directly cites Galton's claim that composites are more beautiful, and the authors provide composite photographs of their own to support their argument (FIG. 5). Beauty, they contend, is natural and universal. "Studies on babies reveal that the preference of facial averageness is biological rather than cultural… the ability to extract the average from a set of realistic facial images operates from an early age, and it is almost instinctive."[38] Babies, in other words, see like Galton. In their examples, however, beauty is in fact fundamentally gendered and racialized; as their caption to the photographs reveals, the images represent "average faces generated by **a** common Caucasians; **b** attractive Caucasians; **c** common Asians; **d** attractive Asians."[39] The circularity of Galton's composites, where faces demonstrate the characteristics of categories that have been determined in advance, is clearly evident here, photographic objectivity providing the ideological labour of covering over these contradictions. The biometric researchers Antitza Dantcheva and Jean-Luc Dugelay outline an even more comprehensive list of aesthetic criteria for the quantification of beauty: "the *golden ratio*, facial *symmetry*, *neonate features*, *averageness*, facial *skin texture*, hair color, femininity, *familiarity*, as well as geometrical attributes of facial features."[40] The golden ratio references the ideal bodily proportions that are a recurring theme in European art history, and also undergird eugenic conceptions of the body. Neonate features designate what they call "babyfacedness," or the purportedly natural association of (implicitly female) beauty with child-like characteristics. Averageness returns us to the nineteenth century deployment of statistical distribution as a category of aesthetic judgement.

In these works, then, we see the profound ways in which system design and normative conceptions of the body are mutually sustaining, relying on connections between aesthetic principles, the technical requirements of biometric systems, and statistically-based automated processing. Indeed, Dantcheva and Dugelay stress that their research combines "three areas, namely classical facial aesthetics, photo-quality and aesthetics as well as image processing based face recognition."[41] Symmetry, averageness, and smoothness simultaneously reduce error rates and express the naturalized facial beauty of classical aesthetics. They also represent quasi-eugenic aesthetico-scientific ideals: "*Symmetry* was evolutionary beneficial [*sic*] for its direct analogy to health."[42] Clearly eugenic ideas have not wholly disappeared—but what are we to make of these claims, especially given that most biometric researchers do not descend to such speculations and that beauty research is a relatively marginal area of biometric science? At the very least, these examples suggest that Wayman's disavowal of any links between a eugenic past and a biometric present requires some scrutiny. To assess this question more fairly, I turn now to biometric research geared explicitly to addressing the kinds of critiques I have been developing here and to diminishing the inequities encoded into biometric system design.

LEARNING TO SEE: TRAINING BIOMETRIC SYSTEMS

In 1884, Francis Galton opened an Anthropometric Laboratory at the International Health Exhibition held at the South Kensington Science Museum in London. Inspired in part by Bertillon's work, he offered money to families in exchange for their anthropometric data, ranging from height and weight to cranial capacity, with his data analysis including the production of composite photographs representing particular racial or characterological types. Galton's dataset ultimately comprised information on more than 9,000 people, the results feeding his biostatistical and eugenic projects.[43] If few today are willing to back explicitly eugenic ideas, the collection and analysis of large anthropometric datasets that was an integral part of Galton's eugenics remains fundamental to biometrics. To understand contemporary biometric research, then, we need to understand the data that feeds it, and remain attentive to the potential eugenic legacies that shape current practices.

The varying algorithmic architectures that govern automated face recognition systems (or any other biometric system) are not programmed with knowledge, they learn it. Machine learning systems, and especially deep learning approaches which seek to mimic the functioning of the human brain,[44] are trained via large datasets—generally arrays of photographs of faces. These are normally annotated by scientists or non-scientist volunteers or workers to highlight characteristics that then guide algorithmic pattern recognition (labelling faces as male or female, for example). To return to previous examples, the *Computer Models for Facial Beauty Analysis* project deployed two training datasets. One encompassed photographs of people from Shanghai, of which 929 were identified as female and 1,384 as male, while the second was only of women and combined images of Miss Universe and Miss World contestants, movies stars, and supermodels with photos of "ordinary" people culled from online sources. These were then given a beauty score by 25 non-scientist volunteers, most in their early 20s, with those ratings then fueling the machine's learning. Dantcheva's and Dugelay's research took a different and perhaps even more questionable approach in using a training dataset of 325 randomly downloaded images and ratings from the website HOTorNOT, which allows users to rate uploaded photographs for "hotness."

These datasets generate obvious methodological problems, most notably in replicating gendered norms and in being deeply unrepresentative (the #OscarsSoWhite campaign, for example, demonstrates the limitations of using celebrities as a dataset). Along with research like that of the Gender Shades project, the recent and rather epic failures of highly visible biometric and other deep learning systems have directed broader attention to the systematic ways in which biometrics replicates and reinforces social inequities. Google's face recognition algorithm achieved particular notoriety after tending to label Black faces as gorillas, while an ACLU test demonstrated that Amazon's Rekognition system, which is being rapidly adopted by police and security agencies, falsely matched 28 members of the US Congress with criminal mugshots.[45] These failures were generally attributed to shortcomings in training, leading major industry players to try to address the dataset problem. Some alternative datasets are designed to address the challenges identified already by Bertillon (PubFig and Columbia Gaze, for example, include occluded, blurred, badly lit, or otherwise "contaminated" images to better train systems to work "in the wild"[46]), but other players in the industry have recognized the need to engage with more structural inequities around race or gender. Certainly, any improvements in this respect are welcome, but, I argue, expanded datasets do not address the fundamental problems inherent in the biometric project, and in some ways they exacerbate them.

A closer look at IBM's "Diversity in Faces" (DiF), perhaps the most significant recent initiative, can help outline the issues at stake. DiF was first announced in 2018 on an IBM research blog, and described as a way to "address the issue of bias head-on."[47] Launched in early 2019, it comprised two new training datasets that aimed to improve system performance, the first encompassing over 1 million images, the second a smaller set of 36,000 geared specifically to "help algorithm designers to identify and address bias in their facial analysis systems."[48] Drawing on the YFCC-100M dataset made up of Creative Commons photographs uploaded to Flickr, the DiF dataset sought to select and annotate a much broader range of embodied characteristics and conditions than in other datasets. The IBM researchers behind the project acknowledge that Flickr still presents problems of representativeness, but more significantly, and despite the professed aim, they offer little substantive critical analysis around what "diversity" and "bias" might mean.

IBM's initial announcement of DiF defined "diversity" as a collection of images that would be "equally distributed across skin tones, genders, and ages." A later post announcing the actual release of DiF in early 2019 expanded on this, but also collapsed more socially significant forms of diversity with a range of other bodily characteristics:

> How do we measure and ensure diversity for human faces? On one hand, we are familiar with how faces differ by age, gender, and skin tone, and how different faces can vary across some of these dimensions… But, as prior studies have shown, these attributes are just a piece of the puzzle and not entirely adequate for characterizing the full diversity of human faces. Dimensions like face symmetry, facial contrast, the pose the face is in, the length or width of the face's attributes (eyes, nose, forehead, etc.) are also important.[49]

Collapsing questions of contrast and pose with those of skin tone or gender reduces socio-political categories to technical ones. The reliance on commonsensical ("we are familiar with") understandings of "race" or "gender" also reinstates a sense that these are transparent categories located solely in the body. In fact, as an academic article outlining the project details, researchers crowdsourced the annotation of the photographs using a 10-part coding scheme that included various anthropometric values similar to those deployed by Bertillon and Galton, including facial symmetry, skin colour, age, and gender, thus encoding the common sense of participants in the dataset.[50] Interestingly, gender was coded along a continuum from 0 to 1, but this seeming acknowledgement of gender fluidity is related by the authors to the challenge of "correctly" identifying binary gendered identities rather than any gender-queer reconceptualization of the kind that Blas, for example, might want us to consider. Worse, in elaborating the aesthetico-scientific basis for these approaches, the authors reference the kind of biometric beauty research discussed earlier (an article on "Facial Attractiveness: Evolutionary Based Research," for example, allows them to associate facial symmetry with attractiveness), but do not draw on anything from the vast critical social scientific and humanities research around human embodiment.

What is crucial here is that "diversity" in DiF relies on a circular logic similar to that which we saw in Galton's work, with the dataset constructed and annotated using pre-determined categories of race and gender, and this dataset in turn feeding the pattern recognition systems that allow biometric systems to identify and categorize bodies as raced or gendered. This enables a profound depoliticization of the body, but also encodes the purported common sense of race and gender at the heart of the system. The idea of "racecraft" put forward by Karen Fields and Barbara Fields captures what is at stake. They point to the tendency of even some anti-racist work (diversity initiatives would be one example) that ultimately remobilize race as a fixed category. Race, they stress, is the product of the social and political practices of violence and exploitation that is rac*ism*, with racecraft designating the practices by which "race" is (incorrectly) constituted as something substantive. Racecraft has its own internal consistencies, logics, and rationalities, they contend, that "occupies a middle ground between science and superstition, an invisible realm of collective understandings, a half-lit zone of the mind's eye."[51] "Race" is a spectre that anti-racist politics should aim to dispel, not mobilize. Biometric science, on the other hand, reinscribes an aesthetico-scientific understanding in which "race" is quantifiable. As Simone Browne argues, this entails a process of "epidermalization—the imposition of race on the body"[52] that marks the continuities linking the branding of the enslaved in the US to the violence of contemporary biometric marking of blackness. The extent to which we are in a "half-lit zone" between science and superstition is evident in ease with which the DiF scientists recall hoary old phrenological and physiognomic arguments, arguing that in fact "skin color alone is not a strong predictor of race, and other features such as facial proportions are important."[53] Coding "diversity" in this aesthetico-scientific context is not a transparent act of reading fixed and self-evident bodily characteristics. Rather, it involves the distribution of the sensible, to return to Rancière's formulation, through which the collection, annotation, and categorization of datasets delimits what does and does not constitute diversity. IBM's DiF may be strongly preferable to a database of celebrity faces, but it still reinforces rather than challenges the desire, dating back at least to the nineteenth century, to render bodies legible, transparent, and differentiated according to fixed, naturalized, and statistically-derived characteristics.

AGAINST BIOMETRICS

Jack Halberstam's *The Queer Art of Failure* provided a key inspiration to Zach Blas's *Facial Weaponization Suite*, the counter-biometric art project with which I began. Halberstam's aesthetics refuses the desire for visibility and legibility so evident in biometric science, arguing instead for a "queer aesthetics… as a catalogue of resistance through failure."[54] Failure itself is not what differentiates this aesthetic, however, in the sense that failure can be mobilized in very different ways. The biometric aesthetic that I have been tracing here is, as I have argued, also necessarily marked by failure, but it is a failure that spurs a desire for an aesthetics of bodily coherence and wholeness, as well as a ravenous hunger for more data. Blas's work parodies this biometric drive. Rather than "unwittingly affirming the validity of constructed truths about measurable biological difference,"[55] as Torin Monahan suggests in his critique of *Facial Weaponization Suite*, Blas pushes us to recognize that the biometric gaze is both irredeemable and highly consequential. While a consideration of the implementation and impacts of biometric technologies is largely beyond the scope of this article, my mentions of racist search engines, the punitive surveillance of poor people, and other such examples highlight the dangerous productivity of biometric failure and its assimilation to, and amplification of, repressive social logics. If the intersecting dynamics of racism, gender, and, through Blas, sexuality, has been my primary focus, we could also extend these analyses further to encompass disability, the role of biometrics in surveillance capitalism, and a host of other critical approaches. These logics register in biometric science not as substantive socio-political questions, but as technical problems associated with the irreducibly fluid and fractal nature of bodies that system designers then seek to stabilize through recourse to a classically-inflected ideal. Halberstam's argument is key here: queer aesthetics is not an aesthetics of failure per se, but rather a refusal of the desire for mastery and control that is so often a response to failure. From this perspective, IBM's DiF differs little from the larger biometric desire for mastery through the production of the aesthetico-scientific unity of a wholly machine-readable body.

That biometrics is irredeemable is evident if we think through possible solutions beyond quantified understandings of "diversity." At a technical level, the only wholly adequate response to the probabilistic nature of algorithmic processing is an infinite training dataset that encompasses all of the possible variations of human being, including the most mundane and minute shifts in lighting and pose. Certainly today's "sensor society," with its automated systems of "passive, distributed, always-on data collection,"[56] pushes us closer to such a dataset, but it will not obviate the need for shortcuts and condensations in biometric system design, with all the problems these entails. Crucially, as Mark Andrejevic and Mark Burdon stress, the drive for total information collection is also resource intensive, and thus only accessible to large institutions like state security apparatuses and major corporate actors. Indeed, the most comprehensive biometric datasets in existence include, for example, those amassed by social media companies, or by the US military's systematic collection of biometric data over the course of its occupation of Afghanistan. In that sense, the drive to "diversify" and expand training datasets is no solution, but rather a recipe for strengthening surveillance capitalism and imperialist logics. Feeding the aesthetico-scientific apparatus of biometric research requires and legitimizes the networks of ubiquitous surveillance in which we are enmeshed and which produce highly differentiated life chances. As with Galton's composites, data from those differentiated forms of life are then fed back into training datasets, those differentiations naturalized and encoded in turn in the resulting technologies. Even when "diversity" is proclaimed as a value, in other words, the drive for biometric efficiency and accuracy is inextricable from the expansionist logic of data-based capitalist accumulation, the demands of the imperialist and racist nation state, and the (re)inscription of normative and non-normative bodies.

NOTES

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