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FOR NOW WE SEE THROUGH AN AI DARKLY; BUT THEN FACE-TO-FACE: A BRIEF SURVEY OF EMOTION RECOGNITION IN BIOMETRIC ART[1]

Abstract: Our knowledge about the facial expression of emotion may well be entering an age of scientific revolution. Conceptual models for facial behavior and emotion phenomena appear to be undergoing a paradigm shift brought on at least in part by advances made in facial recognition technology and automated facial expression analysis. And the use of technological labor by corporate, government, and institutional agents for extracting data capital from both the static morphology of the face and dynamic movement of the emotions is accelerating. Through a brief survey, the author seeks to introduce what he terms biometric art, a form of new media art on the cutting-edge between this advanced science and technology about the human face. In the last ten years, an increasing number of media artists in countries across the globe have been creating such biometric artworks. And today, awards, exhibitions, and festivals are starting to be dedicated to this new art form. The author explores the making of this biometric art as a critical practice in which artists investigate the roles played by science and technology in society, experimenting, for example, with Basic Emotions Theory, emotion artificial intelligence, and the Facial Action Coding System. Taking a comprehensive view of art, science, and technology, the author surveys the history of design for biometric art that uses facial recognition and emotion recognition, the individuals who create such art and the institutions that support it, as well as how this biometric art is made and what it is about. By so doing, the author contributes to the history, practice, and theory for the facial expression of emotion, sketching an interdisciplinary area of inquiry for further and future research, with relevance to academicians and creatives alike who question how we think about what we feel.

Keywords: affective computing, artificial intelligence, Basic Emotion Theory, emotion recognition, Facial Action Coding System, facial expression of emotion, facial recognition, biometrics, media art, physiognomy

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Introduction

Our knowledge about the facial expression of emotion may well be entering an age of scientific revolution. Conceptual models for facial behavior and emotion phenomena have accrued enough explanatory anomalies as to drift into crisis. And face studies appear to be undergoing a paradigm shift. This is brought on at least in part by advances made in facial recognition technology and automated facial expression analysis. Since the 1960s and 1970s, the algorithmic, computational, and digital turns have inspired a Fourth Industrial Revolution or Second Machine Age. The cybernetic, post-digital, and transhuman have come to blur the boundaries between atom and bit, flesh and digital, human and machine. And many of the sensory and cognitive tasks that were previously the exclusive domain of the biological world are now being automated, including facial perception itself. This use of techno-labor for extracting data capital from both the static morphology of the face and dynamic movement of the emotions is accelerating in an increasingly globalized society with its big data surveillance and social media spectacle. As a consequence, stakeholders have a vested interest in face studies not only as pure research but also as applied research that addresses real-world problems. And data on the face has become a commodity or currency with a market value like never before. In response to this clear and present social need, technology companies economically compete to innovate approaches for teaching machines to see the face like a human through artificial intelligence, computer vision, and machine learning. And more and more corporate, government, and institutional agents now are employing facial recognition for the classification, computation, and even control of people on the basis of face. However, there is much uncertainty in the underlying science behind such data behaviorism. And due to an absence of laws and regulations, the use of recognition technology poses complex ethical dilemmas regarding algorithmic transparency, fairness, and accountability, as well as data privacy as a human right.

On the cutting-edge between this advanced science and technology about the face is what I term biometric art. In the last ten years, an increasing number of media artists in countries across the globe have been creating such biometric artworks. And today, awards, exhibitions, and festivals are starting to be dedicated to this new art form. Biometric art as an art form in and of itself is even beginning to be acknowledged in the canons and timelines of art history and visual culture, through anthology, journal, and conference papers,[2] monograph

[2] E. Twardoch, *Are There Stories Hidden Behind Hormonal Spaces and X-Ray Photographs? Around Narratives in Biometrics-based New Media Art*, in: *The Practice of Narrative: Storytelling in a Global Context*, eds. A. Penjak, M. Heitkemper-Yates, Brill, Leiden 2016, pp. 113–122, DOI: 10.1163/9781848883802_012; P. de Vries, W. Schinkel, *Algorithmic Anxiety: Masks and Camouflage in Artistic Imaginaries of Facial Recognition Algorithms*, "Big Data & Society" 2019, Vol. 6, No. 1, pp. 1–12, DOI: 10.1177/2053951719851532.

chapters,[3] and exhibition catalogues,[4] beyond the relevant literature from the field of media art. Given the facial ethos of the early twenty-first century, with its Orwellian phantasms and panoptical overwatch, biometric art critically reflects upon the way recognition technology works and how it is used in society.

Through a brief survey, I seek to introduce this art form which is based upon the contemporary science and technology about the facial expression of emotion. I explore the making of this biometric art as a critical practice in which artists investigate the roles played by science and technology in society (1), experimenting, for example, with Basic Emotions Theory (2), emotion artificial intelligence (3), and the Facial Action Coding System (4). Taking a comprehensive view of art, science, and technology, I survey the history of design for biometric art that uses facial recognition and emotion recognition, the individuals who create such art and the institutions that support it, as well as how this biometric art is made and what it is about. By so doing, I contribute to the history, practice, and theory for the facial expression of emotion, sketching an interdisciplinary area of inquiry for further and future research, with relevance to academicians and creatives alike who question how we think about what we feel.

1. A Critical Practice between Art, Science, and Technology

In the last decade, automated facial expression analysis has more and more been used to discriminate whether or not, to what extent, and under what conditions, emotion is being experienced. This subtype of facial recognition that uses artificial intelligence is called emotion recognition. It has also been defined as "Emotion AI" by computer scientist Rana el Kaliouby, the Chief Executive Officer of Affectiva, a recognition technology company that grew out of The Massachusetts Institute of Technology (MIT) Media Lab in the late 2000s.[5] Broadly speaking, emotion recognition falls un-

3 M. Ożóg, *Życie w krzemowej klatce. Sztuka nowych mediów jako krytyczna analiza praktyk cyfrowego nadzoru* (*Life in a Silicon Cage: New Media Art as a Critical Analysis of Digital Surveillance Practices*), Wydawnictwo Uniwersytetu Łódzkiego, Łódź 2018, pp. 164–170; *Faceless: Re-Inventing Privacy Through Subversive Media Strategies*, eds. B. Doringer, B. Felderer, Edition Angewandte, De Guyter Mouton, University of Applied Arts, Berlin–Vienna 2018; L. Lee-Morrison, *Portraits of Automated Facial Recognition: On Machinic Ways of Seeing the Face (Image)*, Transcript Verlag, Bielefeld 2019, pp. 141–175; K. Fedorova, *Tactics of Interfacing: Encoding Affect in Art and Technology*, The MIT Press, Cambridge, MA 2020, pp. 23–71.

4 *Facial Recognition Exhibition Catalogue*, ed. D. Stein, The Wende Museum, Culver City, CA 2016, https://wendemuseum.files.wordpress.com/2016/05/facial-recognition-catalog.pdf (accessed: 11.12.2019); *Das Gesicht: Bilder, Medien, Formate* (*The Face: A Search for Clues*), ed. S. Weigel, Wallstein Verlag, Göttingen 2017; S. Wirth, *Faszination Gesicht: Was unsere Mimik alles zeigt* (*Fascination Face: What Our Expressions Show*), "Vögelekultur Bulletin" 2019, No. 107, Vögele Culture Center, Pfáffikon, Switzerland.

5 R. El Kaliouby, C. Colman, *Girl Decoded: A Scientist's Quest to Reclaim Our Humanity by Bringing Emotional Intelligence to Technology*, Penguin Books, New York 2020.

der the category of affective computing. This field was first defined in 1995 by computer scientist and electrical engineer Rosalind Picard,[6] who founded the Affective Computing Research Group at MIT, and later co-founded Affectiva with Kaliouby.[7] To Picard, affective computing is "computing that relates to, arises from, or influences the emotions."[8] It has the "aim not just to build machines that have emotional intelligence, but to build tools that help people boost their own abilities at managing emotions, both in themselves and in others."[9] And the actual and potential applications for emotion recognition are indeed considerable.[10] Around 2007, just some forty years the first public exhibition of an automated facial recognition system at the 1970 World Exposition in Japan,[11] facial recognition as well as emotion recognition began to be released for public consumption in the form of commercial products, either open source or black box, such as an Application Programming Interface (API) or Software Development Kit (SDK). And this is when media art enters, and where biometric art that is based on emotion recognition begins.

On the face of it, there is great diversity between works of biometric art based on facial recognition technologies. At first sight, this art may even share forms with other media arts[12] as well as many traditional arts.[13] And a given biometric artwork may combine all manner of materials, such as facial recognition using artificial intelligence, face image databases, computer servers, digital cameras, screens or some other displays, and beyond. But in many if not most biometric artworks, the audience to one degree or another experiences their own face while it is being recognized. And the primary artifact, image, or object that constitutes the work itself principally consists of the matching from data to individual, as the face of the person interacting

[6] R.W. Picard, *Affective Computing*, *Tech. Report: 321*, The MIT Press: MIT Media Lab, Cambridge, MA 1995.

[7] Affectiva, *Affectiva*, n.d., https://www.affectiva.com/ (accessed: 11.12.2019).

[8] R.W. Picard, *Affective Computing*, The MIT Press, Cambridge, MA 1997, p. 99.

[9] *Eadem*, *Toward Machines with Emotional Intelligence*, in: *Proceedings of the First International Conference on Informatics in Control, Automation and Robotics*, ICINCO 2004, Setúbal, Portugal, August 25–28, 2004, p. 19, DOI: 10.1093/acprof:oso/9780195181890.003.0016.

[10] Today, real-world applications for facial recognition and emotion recognition include, for example: augmented or virtual reality, consumer marketing, film and game animation, healthcare systems, lie detection, human-computer interaction, law enforcement, military perception, smart devices and environments, social robotics, and beyond.

[11] D. Schiller, *On the Basis of Face: Biometric Art as Critical Practice, its History and Politics*, Institute of Network Cultures, Amsterdam 2020.

[12] Biometric art based on facial recognition can intersect and overlap with a multitude of other art forms in media art, including, for example: algorithm or computer art; augmented, mixed, or virtual reality art; bioart (art which uses life processes and living organisms); brain-computer interface art; digital fashion design; game design; interactive and/or immersive installation art; internet or net art; performance or happenings; and robotics-based art.

[13] Biometric art can also share formal elements with traditional art forms, including, for example: applied arts such as architecture, ceramics, or fashion design; fine arts such as drawing, painting, film, photography, or sculpture; and performance arts such as dance or theatre.

with the work is compared to the faces of those people archived in a database. That is, as media art theorist Ksenia Fedorova analyzes,[14] the audience and their face act upon the artwork, which itself affords for this interaction, enabling a multipath informational exchange between artwork and audience, whereby the artifact, image, or object changes somehow in response to this interactor or participant. Because of the way facial recognition works, this basic design is relatively consistent across biometric art. And, to analogize from biology to culture in the poetics of nineteenth century naturalist Charles Darwin, "it is from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved."[15]

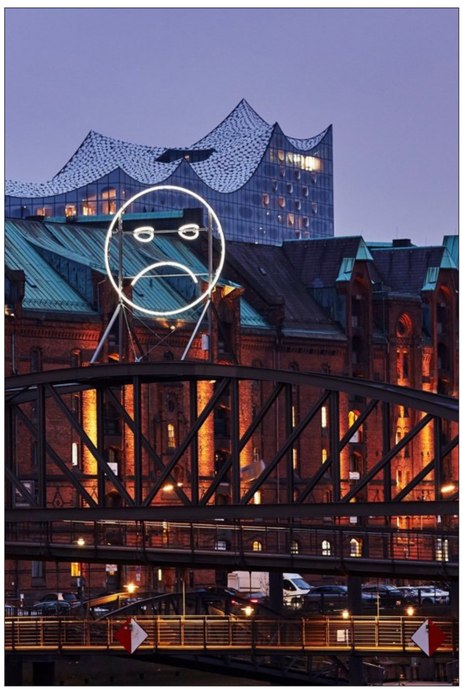
Essentially, a biometric artwork is an intelligent machine. As computer scientist and pioneering computer artist Frieder Nake argues, such an art form consists triadically of a subface, interface, and surface.[16] The subface is the program or software that runs on a computer, in this case the facial recognition using artificial intelligence, as well as the machine or hardware that executes a code. The interface is the shared boundary across which the separate components of this system exchange inputs. And the surface is the output device that generates an image or other effects from this code. In a biometric artwork, therefore, facial recognition technology is but one material out of many that has been intermedially combined by the artist, multi-artist collaboration, or interdisciplinary group. As philologist Irina O. Rajewsky examines, with intermedial combination, each form of articulation plays a role in determining the media specificity for the newly-formed object and, in turn, contributes to its signification.[17] Thus, hybridized into the biometric artwork may be analogue as well as digital media, not only sensory but also computable information, human participants and machine provocateur, all within a complimentary generative process of becoming.

14 K. Fedorova, *Tactics of Interfacing…*, *op. cit.*, pp. 23–71.

15 C. Darwin, *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*, John Murray, London 1859, p. 490.

16 F. Nake, *Surface, Interface, Subface: Three Cases of Interaction and One Concept*, in: *Paradoxes of Interactivity: Perspectives for Media Theory, Human-Computer Interaction, and Artistic Investigations*, eds. U. Seifert, J. Hyun Kim, A. Moore, Transcript, Bielefeld 2008, pp. 105–107, DOI: 10.25969/mediarep/2719.

17 I.O. Rajewsky, *Intermediality, Intertextuality, and Remediation: A Literary Perspective on Intermediality*, "Intermédialités" 2005, No. 6, pp. 51–53, DOI: 10.7202/1005505ar.



Figs. 1 and 2: Julius von Bismarck, Benjamin Maus, and Richard Wilhelmer, *Public Face*, 2007. Installation view from 2018, Kibbelsteg Bridge over the Elbe River, Hamburg, Germany. Photographs © Carsten Dammann. Used with permission

For example, one of the earliest biometric artworks, researched and developed in 2007, was German media artist Julius von Bismarck, German digital designer Benjamin Maus, and Austrian filmmaker Richard Wilhelmer's *Fühlometer* (*Feel-O-Meter*), later re-titled *Public Face* (Figs. 1 and 2).[18] To create this biometric artwork, the artists intermedially combined both contemporary and conventional technologies within a pluri-medial constellation. They used a subface of recognition technology on computer servers; an interface of digital cameras with telephoto lenses; and a surface of fluorescent neon tubes and steel buttressing sculpture in the shape of colossal smiley that weighs one-and-a-half tons and has an eight-meter circumference.[19] During a group interview with the press, Wilhelmer states that they "wanted to playfully represent" the ways in which facial recognition technology can be "applied for control above all" in machines "that use established standards to assess how we behave and which facial expression suggests which behavior."[20] According to the group's artist statement, "[d]ue to its immense scale, the sculpture becomes part of the skyline, and its varying expressions can be seen from far away," while *Public Face* makes "the changing, average emotions of city inhabitants visible to everyone in public space."[21]

In the subface for *Public Face*, media artists Bismarck, Maus, and Wilhelmer used the Sophisticated High-speed Object Recognition Engine (SHORE) Framework from the Fraunhofer Institute for Integrated Circuits (IIS) in Erlangen, Germany.[22] As computer scientists Tobias Ruf, Andres Ernst, and Christian Küblbeck specify in a technical paper, SHORE supports facial detection in both still images and moving videos based on the extraction of sixty-eight facial landmarks as well as real-time classification for age, gender, and the facial expression of emotion.[23] And indeed,

[18] J. von Bismarck, *Public Face II*, 2010, http://juliusvonbismarck.com/bank/index.php?/projects/public-face-ii/ (accessed: 11.12.2019); R. Wilhelmer, *Fühl-O-Meter*, 2010, http://richardwilhelmer.com/projects/fuhl-o-meter (accessed: 11.12.2019).

[19] See: D. Schiller, *Face, A Keyword Story: The Archiving Vocabulary for Facial Expression in the German Imaginary from Printed Text to Digital Image*, in: *Digital. Media and Textuality: From Creation to Archiving*, ed. D. Côrtes Maduro, Transcript Verlag, Bielefeld 2017, pp. 207–252, DOI: 10.14361/9783839440919-013.

[20] E. Kaczor, *Julius von Bismarck und der Smiley über Berlin*, "ART Berlin", 2.06.2012, http://www.artberlin.de/kuenstler/julius-von-bismarck-smiley (accessed: 11.12.2019). Translated from the German by the author.

[21] J. von Bismarck, *Public Face II*, *op. cit.*

[22] Fraunhofer Institute for Integrated Circuits (IIS), *SHORE Face Detection Software*, https://www.iis.fraunhofer.de/en/ff/sse/ils/tech/shore-facedetection.html (accessed: 11.12.2019). The Fraunhofer IIS is one of seventy-two institutes worldwide in the Die Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. (The Fraunhofer Society for the Advancement of Applied Research). And the SHORE software library was developed with the support of a European Commission grant (#FP6-2005-ISt-5) for Information Society Technologies (IST).

[23] T. Ruf, A. Ernst, C. Küblbeck, *Face Detection with the Sophisticated High-speed Object Recognition Engine (SHORE)*, in: *Microelectronic Systems: Circuits, Systems and Applications*, eds. A. Heuberger, G. Elst, R. Hanke, Springer Verlag, Heidelberg 2011, pp. 243–252, DOI: 10.1007/978-3-642-23070-7_23.

SHORE was particularly suited to Bismarck, Maus, and Wilhelmer's artistic project for two reasons. Firstly, SHORE achieves robust face detection as far down as an 8x8 pixel minimum. Therefore, *Public Face* could include within its processes for recognition those face images of numerous passersby taken by camera at a considerable distance. And secondly, as explained by Jens Garbas, former head of the Image Analysis and Pattern Recognition department at Fraunhofer IIS that developed this recognition technology, SHORE neither stores nor transmits data, but rather produces only anonymous metainformation; it is "privacy by design."[24] Therefore, *Public Face* could not include these passersby as individuals per se within its processes for recognition. Because SHORE had been trained for both face marker annotations as well as emotion class attributes, and its performance benchmarked or evaluated on several face image databases,[25] its face model could "then be applied to detect similar objects in yet unseen images."[26] A "user or client […] only needs to know how to configure it and integrate it into a larger scale application,"[27] such as artists into an artwork.

At the interface for *Public Face*, Bismarck, Maus, and Wilhelmer mounted digital single-lens reflex cameras (DLSR) with 200–500mm f/2.8 APO EX DG Ultra-Telephoto zoom lenses produced by the Sigma Corporation of America. When the artwork is active, digital images of passersby from these cameras are input for data processing. The way SHORE works is by detecting faces in digital images of faces within their environment, extracting census features away from and out of these image data, and classifying these faces "at pixel level" by matching them to face models, also termed prototypes or templates, "specifying how positive or negative its expression is."[28] Output in Extensible Markup Language (an XML file),[29] this real-time aggregate metadata then prompts a sequence of actions for the sculptural installation.

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24 J. Garbas, *SHORE Image Analysis: Data-Protection Compliant and Certified, Interview with Jens Garbas*, Fraunhofer IIS, 2017, https://www.iis.fraunhofer.de/en/magazin/2017/datenschutz-shore.html (accessed: 11.12.2019).

25 These face image databases included the Carnegie Mellon University + Massachusetts Institute of Technology (CMU+MIT) Database, BioID, Facial Recognition Technology (FERET) Database, and the Japanese Female Facial Expression (JAFFE) Database. C. Wang, *Frontal Face Images*, *CMU Image Data Base: Face*, 2000, http://www.cs.cmu.edu/afs/cs/project/vision/vasc/idb/www/html_permanent/index.html (accessed: 11.12.2019); BioID, *BioID Face Database*, https://www.bioid.com/About/BioID-Face-Database (accessed: 11.12.2019); P.J. Phillips, H. Moon, S.A. Rizvi, P.J. Rauss, *The FERET Evaluation Methodology for Face-Recognition Algorithms*, "IEEE Transactions on Pattern Analysis and Machine Intelligence" 2000, Vol. 22, No. 10, pp. 1090–1104, DOI: 10.1109/34.879790; M.J. Lyons, J. Budynek, S. Akamatsu, *Automatic Classification of Single Facial Images*, "IEEE Transactions on Pattern Analysis and Machine Intelligence" 1999, Vol. 21, No. 12, pp. 1357–1362, https://doi.org/10.1109/34.817413

26 T. Ruf, A. Ernst, C. Küblbeck, *Face Detection…*, *op. cit.*, p. 238.

27 *Ibidem*.

28 Fraunhofer IIS, *Press Release: GfK EMO Scan Wins 2012 German Innovation in Market Research Award*, 18.07.2012, https://www.iis.fraunhofer.de/content/dam/iis/en/doc/pr/2012/201207112_PI_EMO_Scan_e.pdf (accessed: 11.12.2019).

29 T. Ruf, A. Ernst, C. Küblbeck, *Face Detection…*, *op. cit.*, p. 240.

And on the surface of *Public Face*, the face of the artwork changes to reflect the emotions of the viewers, at least insofar as this majority is reported by SHORE, the facial recognition using artificial intelligence in the biometric artwork. With the smiley made from neon and steel, the semi-circular curve of the mouth as well as the separate half-circle upper and lower eyelids rotate on the horizontal axis in order to produce those facial expressions that are commonly associated with anger >_<, happiness :), sadness :(, and surprise 0_0. For the viewer, the aesthetic experience with Bismarck, Maus, and Wilhelmer's *Public Face*, like with Javier Hernandez and Mohammed Ehsan Hoque's (US) *Mood Meter* (2011),[30] created four years later in 2011 at the MIT Media Lab also using Fraunhofer's SHORE,[31] requires an understanding of the sculpture as an icon in relation to other smileys. The history of such design spans from anthropomorphic pictograms and typographic art, to the yellow smiley ☺ designed by graphic artist Harvey Ball in 1963 for State Mutual Life Assurance, and ASCII :-) character sequence first proposed by computer scientist Scott Fahlman in 1982 on a Carnegie Mellon University online bulletin board.[32] As Wilhelmer states, "people see the smiley face and find it funny."[33] Then they learn that *Public Face* "can read emotions, and that's funny as well. But in this instance, the laughter gets stuck in your throat because you think: what if this software falls into the wrong hands?"

There is, therefore, more to a work of biometric art that uses emotion recognition than meets the eye. And this art form should not be taken at face value. In contrast to "traditional images" which are the "observation of objects," as media philosopher Vilém Flusser articulates, these "technical images" are the "computation of concepts."[34] And the understanding of such an image, according to media theorist Mark B.N. Hansen, "can no longer be restricted to the level of surface appearance, but must be extended to encompass the entire process by which information is made

30 J. Hernandez, M. Ehsan Hoque, *Mood Meter*, 2011, https://moodmeter.media.mit.edu (accessed: 11.12.2019); J. Hernandez, M. Ehsan Hoque, W. Drevo, R.W. Picard, *Mood Meter: Counting Smiles in the Wild*, in: *UbiComp '12: Proceedings of the 2012 Association for Computing Machinery (ACM) Conference on Ubiquitous Computing*, eds. A.K. Dey, H.H. Chu, G. Hays, Association for Computing Machinery, New York 2012, pp. 301–310, DOI: 10.1145/2370216.2370264.

31 Indeed, ten years after the Fraunhofer first released SHORE, the number of media artists who have used this recognition technology has increased to the point that they are considered as potential customers and a target market. Now, when downloading a trial version, the online registration form even allows customers to submit their "market segment" as "art/installations." Fraunhofer IIS, *SHORE Demo Software*, https://www.iis.fraunhofer.de/en/ff/sse/imaging-and-analysis/ils/dl/shore/terms.html (accessed: 11.12.2019).

32 D. Schiller, *Eco's Face Drawing and the Continuum of Emoticon Articulation*, in: *Umberto Eco in His Own Words*, eds. T. Thellefsen, B. Sørensen, De Gruyter Mouton, Berlin 2017, pp. 57–70, DOI: 10.1515/9781501507144-009.

33 E. Kaczor, *Julius von Bismarck…*, *op. cit.* Translated from the German by the author.

34 V. Flusser, *Into the Universe of Technical Images*, transl. N.A. Roth, University of Minnesota Press, Minneapolis, MN 2011, p. 10. Originally published in German as *Ins Universum der technischen Bilder*, European Photography, Berlin 1985.

perceivable".[35] But perhaps the biggest difference that makes a difference in the way biometric art works is its classifier. A classifier is a predictive model which is used to map from input variables to output variables. However, today in biometric art, as in recognition technology, there is great diversity in such categories, labels, or targets, as the classifier is variously termed in the computer sciences. Such classifiers are what the faces of the viewer, participant, or interactor are compared to and matched with as the biometric artwork performs facial recognition.

Given today's ever-expanding application of automated facial expression analysis in affective computing and emotionAI, an ever-increasing number of media artists use not only facial recognition but also emotion recognition in their biometric artworks. The classifier, in these cases, is not gender or race, celebrity or criminality, but some concept or other of what emotions are and what they do. That is, the classification of emotion on the basis of face by facial recognition using artificial intelligence foremost depends upon the concept of what emotion is in the first place. After all, at this moment in the technological evolution of the human species, a machine cannot learn to see faces and emotions like a human (simulation), a human cannot see more with a machine (prosthetic), and a machine and a human can see differently together (augmentation), unless a human first teaches a machine what the facial expression of emotion is. These terms must be defined for the artificial intelligence. And thus, the facial behavior and emotion phenomena may be approached differently in different artworks, largely dependent on the concepts underlying the facial recognition technology.

2. Basic Emotions Theory (BET)

Teaching machines to see the face like a human requires interdisciplinary exchange between the computer sciences which make recognition technology and the brain and behavioral sciences which theorize about facial expression of emotion.[36] But there is much debate, across disciplines such as cognitive science, psychology, and neuroscience over what emotions are and what they do.[37] However, from all theories for the facial expression of emotion, such as the Behavioral Ecology View[38] proposed by social psychologist and human ethologist Alan J. Fridlund, or the Constructed Emotion Theory proposed by neuropsychologist Lisa Feldman Barrett,[39] Basic Emotions

[35] M.B.N. Hansen, *Bodies in Code: Interfaces with Digital Media*, Routledge, New York 2006, p. 10.

[36] C.L. Lisetti, D.J. Schiano, *Automatic Facial Expression Interpretation: Where Human-Computer Interaction, Artificial Intelligence and Cognitive Science Intersect*, "Pragmatics and Cognition: Special Issue on Facial Information Processing: A Multidisciplinary Perspective" 2000, Vol. 8, No. 1, pp. 186–187, DOI: 10.1075/pc.8.1.09lis.

[37] N.H. Frijda, *The Psychologists' Point of View*, in: *The Handbook of Emotions*, 3rd Edition, eds. M. Lewis, J.M. Haviland-Jones, L.F. Barrett, The Guilford Press, New York 2008, pp. 68–87.

[38] A.J. Fridlund, *Human Facial Expression: An Evolutionary View*, Academic Press, San Diego 1994.

[39] L.F. Barrett, *How Emotions Are Made: The Secret Life of the Brain*, Houghton Mifflin Harcourt, Boston 2017.

Theory has proven by far the most significant to recognition technology as well as biometric art.

Advocates for Basic Emotions Theory (BET), sometimes also called the Basic Emotions View or Theory of Universality, notably include psychologists Silvan S. Tomkins, as well as Carroll E. Izard and Paul Ekman, who were both mentored by Tomkins in the 1960s around the same time that facial recognition began. The primary claim in Basic Emotions Theory is threefold: Firstly, the facial expression of emotion is prototypical, specified by biology. Secondly, it is more or less universal across cultures. And thirdly, there is a causal link between an outside physiological behavior of the facial expression and the inside psychological phenomena of an emotion that emanates it. Variability to innate expression, therefore, is largely determined by learned expression through social scripts and display rules; that is, by the over-coding from culture onto biology. Neurobiologically speaking, so-called basic emotions like anger, contempt, disgust, fear, happiness, sadness, or surprise are defined and described as phylogenetically stable and functionally discrete neural circuits that activate with the appraisal of stimuli and trigger patterns of response, such as the anatomical mechanics and movements that produce facial expression.[40]

The advocates for Basic Emotions Theory most frequently cite nineteenth century naturalist Charles Darwin as its intellectual father and his *The Expression of Emotion in Man and Animals* in 1872 as its foundational text.[41] In *The Expression*, Darwin hypothesized that the facial expression of emotion "once existed in a much lower and animal-like condition" and "every true or inherited movement of expression seems to have had some natural and independent origin."[42] His claim, however, was not that facial morphology evolved in order to express or display emotion. Actually, Darwin proposed that facial behavior is more akin to a rudimentary or vestigial feature like the appendix, body hair, tail bone, or wisdom teeth. It is "of no service, often of much disservice" and "purposeless."[43] To Darwin, the facial expression of emotion is a remnant of reflexes that had once been useful, arising from the antithesis of contrasting elicitors, the direct action of the nervous system in the overflow of excitation. As such, he wrote that it was "highly important to ascertain whether the same expressions and gestures prevail, as has often been asserted without much evidence, with all of the races of mankind"; that is, whether and to what extent the facial expression of emotion is universal.[44]

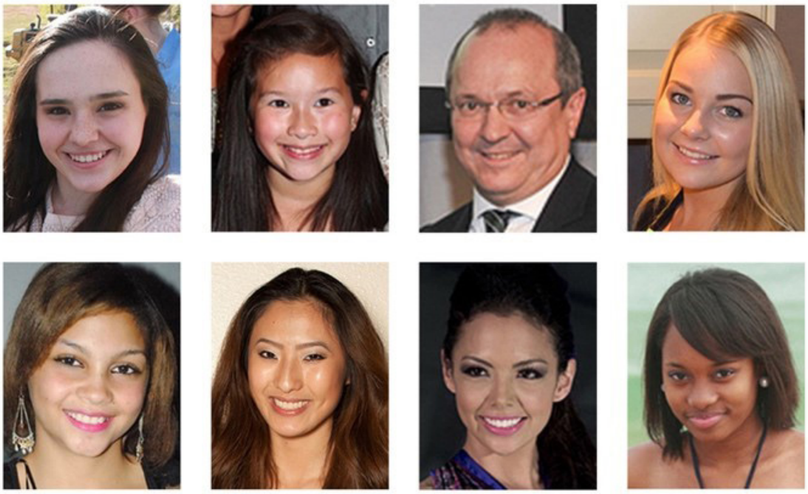
[40] W.E. Rinn, *The Neuropsychology of Facial Expression: A Review of the Neurological and Psychological Mechanisms for Producing Facial Expressions*, "Psychological Bulletin" 1984, No. 95, pp. 52–77, DOI: 10.1037/0033-2909.95.1.52.

[41] P. Ekman, *Darwin's Contributions to Our Understanding of Emotional Expressions*, "Philosophical Transactions of the Royal Society B" 2009, No. 364, pp. 3449–3451, DOI: 10.1098/tstb.2009.0189.

[42] C. Darwin, *The Expression of the Emotions in Man and Animals*, John Murray, London 1872, pp. 12, 356.

[43] *Ibidem*, pp. 67, 76.

[44] *Ibidem*, p. 15.



Figs. 3 and 4: Shin Seung-Back and Kim Yong-Hun, *Cat or Human*, 2013. Detail view. Used with permission

In the history of face studies from classical physiognomy to current biometrics, Darwin made the first systematic endeavor to link the facial signals of animals to the facial expressions of humans. And some one-hundred-and-fifty years after *The Expression of Emotion* hit the shelves in 1872, media artists play with Darwin's dangerous idea in their biometric artworks: that the purpose for life might not need a designer and that natural selection, albeit a blind mechanism, is nevertheless sufficient to justify the processes of evolution. For example, in 2013 with *Cat or Human* (Figs. 3 and 4), South Korean engineer Shin Seung-Back and artist Kim Yong-Hun, who as an artist duo go by the name Shinseungback Kimyonghun, used facial recognition designed for cats (*Felis silvestris catus*) on humans and facial recognition designed for humans (*Homo sapiens sapiens*) on cats.[45] Of course, there are similarities between the facial morphologies of humans, other primates, and non-primate mammals due to shared phylogenetic heritage.[46] And scientific methods, practices, and tools currently exist for the comprehensive description of the facial expression of emotion in the orangutan, macaque, gibbon, and chimpanzee,[47] as well as horse, dog, and cat.[48] But by applying recognition technologies interspecifically or between species, Seung-Back and Yong-Hun critically reflect, as Darwin did, upon the most fundamental characteristics of the face and its perception.

To create this biometric artwork, Shin Seung-Back and Kim Yong-Hun web-scrapped digital images from the online image hosting service Flickr. The images that they chose were posted under the Creative Commons Attribution 2.0 Generic (CC BY 2.0) and so were free for them to share or adapt. Having collected the images, the artists then organized two data sets: one for images showing cat faces and one for images showing human faces. And then, so that *Cat or Human* recognized people who look more like cats and cats who look more like people, Seung-Back and Yong-Hun used facial recognition technology designed for one species on the other species and vice versa, OpenCV Face Recognizer[49] for cat face images, and Kittydar[50] for human face images. Kittydar was developed by computer scientist Heather Arthur,[51] based on research by computer scientists Weiwei Zhang, Jian Sun, and Xiaoou Tang,[52] and disseminated open source on GitHub under an MIT License. Trained on thousands upon thousands of images that showed cats as well as non-cats, the way Kittydar works is

45 S. Seung-Back, K. Yong-Hun, *Cat or Human*, 2013, http://ssbkyh.com/works/cat_human/ (accessed: 11.12.2019).

46 A. Wilkins, *Making Faces: The Evolutionary Origins of the Human Face*, Harvard University Press, Cambridge, MA 2017, pp. 123–171.

47 Animal FACS, *Animal Facial Action Coding Systems (FACS)*, Psychology Department, University of Portsmouth, http://animalfacs.com/index.html (accessed: 11.12.2019).

48 C. Caeiro, A. Burrows, B.M. Waller, *Development and Application of CatFACS: Are Human Cat Adopters Influenced by Cat Facial Expressions?*, "Applied Animal Behaviour Science" 2017, No. 189, pp. 66–78, DOI: 10.1016/j.applanim.2017.01.005.

49 P. Wagner, *Face Recognition with OpenCV2*, Open Source Computer Vision (OpenCV), 2012 https://docs.opencv.org/3.3.1/da/d60/tutorial_face_main.html (accessed: 11.12.2019).

50 H. Arthur, *Kittydar: Face Detection for Cats in JavaScript*, GitHub, 2012, http://harthur.github.io/kittydar/ (accessed: 11.12.2019).

51 *Ibidem*.

52 W. Zhang, J. Sun, X. Tang, *Cat Head Detection: How to Effectively Exploit Shape and Texture Features*, in: *Computer Vision – ECCV 2008: 10th European Conference on Computer Vision, Marseille, France, October 12–18, 2008, Proceedings, Part IV*, eds. D. Forsyth, P. Torr, A. Zisserman, Springer Verlag, Berlin–Heidelberg 2008, pp. 802–816, DOI: 10.1007/978-3-540-88693-8-59.

by dividing a digital image into a series of windows, and then testing each window in order to detect for the absence or presence of a cat face. For each of these localized image segments, Kittydar extracts tractable image data, or data that is more easily shaped or worked, away from and out of the total image data. Kittydar achieves this by counting the occurrences of gradient orientation in each image window, recognizing edge change from light to dark and from dark to light, its direction, and strength; that is, using Histogram of Orient Gradients (HOG) and the HOG-descriptor library. A vector of these numbers, with both direction and magnitude, is then fed into a neural network, which classifies the likelihood that this data represents a cat on a scale from 0 to 1.

With facial perception in the human visual system, the attributes of the face and its features such as color, contrast, edge, form, light, luminosity, shape, and beyond, all play a part in our ability to detect the face as well as distinguish it from other objects in the environment.[53] In *Cat or Human*, as Seung-Back and Yong-Hun observe, "[c]omputer vision can take many different strategies to detect a human face or a cat face," considering "skin texture, shape, mathematical features, etc."[54] The "[c]omputer often mistakes one for another," a cat for a human and a human for a cat, "and the similarities are visible to human eyes, too." This is no "mere error resulted by the immaturity of the technology" but a key feature of facial recognition. And with *Cat or Human*, Seung-Back and Yong-Hun explore the ways in which a machine can see like the human, "the error can raise the question of how computer vision works," and "help us understand the mechanisms of human vision." With *Cat or Human*, however, Seung-Back and Yong-Hun reflect upon the differences that separate the facial expression of emotion in human and nonhuman animals, and how these differences are one of degree and not of kind, in a critique of anthropocentrism and essentialism. Post-Darwin, however, the central mission in face studies has gradually and incrementally turned from the perception of static facial morphology to the interpretation of dynamic facial movement. In other words, since the mid-twentieth century, research about the face has endeavored to establish links between facial behavior and emotion phenomenon.

3. Emotion Artificial Intelligence (EmotionAI)

This is not to say that all of the concepts today about what emotions are and what they do are homogenous. Not at all. Concepts vary between researchers as well as across an individual researcher's body of work. And there is much debate in the

[53] For example, see: *Oxford Handbook of Face Perception*, eds. A.J. Calder, G. Rhodes, M.H. Johnson, J.V. Haxby, Oxford University Press, Oxford–New York 2011; D. Schiller, *Greening Face: How Color Makes Facial Expression Sensible, from Pre-Christian Architectural Spaces to Post-Digital Smart Environments*, "Arts & Cultural Studies Review" 2018, Vol. 4, No. 38, pp. 493–534, DOI: 10.4467/20843360PK.18.026.10364.

[54] M. Sick-Leitner, *Featured Artists 2014 Ars Electronica*, *Ars Electronica Blog*, 18.09.2014, https://ars.electronica.art/aeblog/en/2014/08/18/featured-artists-ars-electronic-2014/ (accessed: 11.12.2019).

scientific community over the merits and limitations of Basic Emotions Theory, particularly coming out of the neurosciences.[55] For instance, as historian of science Ruth Leys traces, criticisms include how Basic Emotions Theory fails to take into account the role played by context and culture in the facial expression of emotion, the degree to which such facial expression is part of social intent, and how it serves to guide actions not only reactively but predictively as well. To a greater and greater extent, today facial expression is considered to be affected by culturally specific and socially variable conventions, to reflect blended rather than discrete emotions, and to be not only aroused by emotion but also activated by it. Indeed, the paradigm keeps on turning and Basic Emotions Theory may not be where the science will be tomorrow.

Some media artists critically reflect upon the role played by context in the communications of face and emotion. For example, in 2016 with *Neutralité: Can't and Won't*, Chinese-born, Canada-based fashion designer Ying Gao fabricated dresses that use facial recognition as well as emotion recognition (Figs. 5 and 6).[56] In her own words, according to her artist statement, "design is the medium" for Gao.[57] And she describes her body of work as an exploration into "the status of the individual" who today is being transformed through "external interferences," testifying "to the profound mutation of the world in which we live," in a critical reflection "that transcends technological experimentation." Recognition technologies such as eye tracking[58] and facial recognition,[59] therefore, "allow garments to become more poetic and interactive."[60] The dresses for *Neutralité* were made from cotton mesh; polyvinylidene difluoride (PVDF), a low-density and non-reactive plastic; and super organza, a polyester fabric with a density of only seven deniers, as in ultra-sheer leggings, stockings, or tights, one-fifth the thickness of a human hair, and weighing only ten grams per square meter. But the dresses were also made from what Gao calls "electronic devices." This includes facial recognition technology, with all its necessary algorithms, cameras, computers, and databases, in an artificial intelligence which is situated locally in the dress itself as well as remotely elsewhere in the room.

Exactly the way recognition technology works in *Neutralité: Can't and Won't*, and how Ying Gao uses it, is not possible to say. This is because Gao "does not answer questions regarding technical details" (Ying Gao Studio, email communication with

55 For example, see: A. Celeghin, M. Diano, A. Bagnis, M. Viola, M. Tamietto, *Basic Emotions in Human Neuroscience: Neuroimaging and Beyond*, "Frontiers in Psychology" 2017, Vol. 8, No. 1432, pp. 1–29, DOI: 10.3389/fpsyg.2017.01432.

56 Y. Gao, *Neutralité: Can't and Won't*, 2016, http://www.yinggao.ca/interactifs/neutralite--cant-and-wont/ (accessed: 11.12.2019).

57 *Eadem*, *Profile*, http://yinggao.ca/info/profile/ (accessed: 11.12.2019).

58 C. Jones, *What You Staring At? Ying Gao's Gaze-Activated Dresses*, "Vice", 19.06.2013, https://www.vice.com/en_us/article/ez5g47/ying-gaos-gaze-activated-dresses (accessed: 11.12.2019).

59 S. Press, *Dresses that React to the Emotions of Viewers*, "Ignant" 2016, https://www.ignant.com/2017/02/03/dresses-that-react-to-the-emotions-of-viewers/ (accessed: 11.12.2019).

60 Y. Gao, *Neutralité…*, *op. cit.*

the author, 22 July 2019), primarily in order to protect her intellectual property in the fashion world. However, as Gao depicts in her artist statement, *Neutralité* displays "an aesthetic and motion reminiscent of microbial life" with its "balletic back and forth" in "robotized movements and shadow plays" between the dress and a spectator.[61] When a spectator enters the room to view the dress, the artificial intelligence that uses recognition technology detects, extracts, and classifies their facial expression of emotion. It then converts this data into an instruction which is sent to the devices of the dress and which tells the dress to perform certain actions and specific tasks, such as illumination or movement.[62] But the dress only activates if the interactor does not respond emotionally and if their face stays at "neutral." That is, if the spectator holds their face still and does not move a muscle, if they maintain a neutral facial expression, and if the technology fails to recognize any facial expression of emotion, then and only then will the dress "light up" and "move about." Thus "[b]eing asked to take an active part in a 'living' system," the spectator "becomes a component of a self-generated ecosystem" which signifies the plurality of potential relations both within and between living organisms.

Figs. 5 and 6: Ying Gao, *Neutralité: Can't and Won't*, 2016. Photos © Dominique Lafond. Used with permission

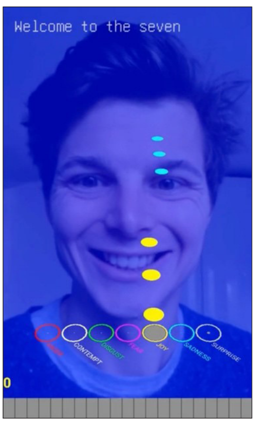
Beyond its failure to take into account the contextuality of an expression, additional problems with Basic Emotions Theory when it is applied in artificial intelligence which uses recognition technology become apparent through certain works of

[61] *Ibidem*.

[62] S. Press, *Dresses that React…, op. cit.*

biometric art. Indeed, Dutch media artist Ruben van de Ven, among others, directly addresses the way Basic Emotions Theory works and how it is used in EmotionAI. With a background in computer programming, film making, and media design, he "challenges alleged objective practices" through his studio art.[63] Van de Ven investigated "the computational quantification and categorization of emotions" in his thesis project at the Piet Zwart Institute in Rotterdam, Netherlands, in 2016. And it was there during his master's that van de Ven began to create a series of biometric artworks, including *Choose How You Feel; You Have Seven Options*, *Emotion Hero*, and *EYE Without a Face*, in which he critically reflects upon this "model of seven emotions."[64]

In 2016 with *Emotion Hero* (Figs. 7 and 8), for example, Ruben van de Ven used recognition technology to create a mobile game. Players "train for the right emotional response in *every* situation."[65] The game provides "detailed feedback to improve your score, so you can keep on playing." And all players compete worldwide "to become the one and only Emotion Hero!" Sponsored by the V2_Lab for the Unstable Media in Rotterdam, Netherlands, interactors had the opportunity to experience the artwork in two forms: as a mobile application for Android devices (phone or tablet) free to download from Google Play;[66] and as a video projection that showed aggregate scores from gameplay as well as live updates.



Figs. 7 and 8: Ruben van de Ven, *Emotions Hero*, 2016. (Left) screen capture of video game version on Android phone, showing also the portrait of the artist. (Right) exhibition view with photograph of phone app (foreground) and video projection (background) from the 2016 STATE of Emotion Festival in Berlin, Germany. Used with permission

63 R. van de Ven, *Choose How You Feel; You Have Seven Options*, Institute of Network Cultures (INC) Longform, Amsterdam 2017, p. 22, http://networkcultures.org/longform/2017/01/25/choose-how-you-feel-you-have-seven-options/ (accessed: 11.12.2019).

64 *Ibidem*, p. 6.

65 *Idem*, *Emotion Hero*, *Proceedings of the 2017 ACM SIGCHI Conference on Creativity and Cognition* (C&C '17), 2017, pp. 422–423, DOI: 10.1145/3059454.3059490/.

66 *Idem*, *Emotion Hero: Android App*, Google Play Store, 2017, https://play.google.com/store/apps/details?id=com.rubenvandeven.emotion_hero (accessed: 11.12.2019).

The biometric artwork *Emotion Hero* first produced by Ruben van de Ven in 2016 was inspired by the video game *Guitar Hero* first published by RedOctane and Harmonix in 2005. With *Guitar Hero*, the player uses a game controller shaped like a guitar in order to simulate playing lead, bass guitar, or rhythm guitar across numerous rock music songs. With *Emotion Hero*, the player uses their smartphone or tablet in order to simulate the facial expression of emotion across numerous prompts and tasks. Once a player has launched *Emotion Hero*, the landing page that welcomes them also provides instructions for game play: "The bar below shows your current feelings. Feel the emotions as they are given by the dots that come down on the screen. If you feel them, we detect them!"[67] As a player interacts with *Emotion Hero*, each level of the game has an increasingly progressive degree of difficulty, in which a player needs to meet specific goals or perform a specific task in order to advance. Game levels include: "Welcome to the Seven" (in reference not to DC's Justice League but to Ekman's Basic Emotions Theory); "Smile like you mean it;" "Let's talk business;" "Show me what you really feel;" and "Please act normally." The player "scores points by following given cues and making the required facial expressions," while the game "provides detailed feedback on the mechanics of the players' face and suggests ways to 'improve' ones' facial expression of a certain emotion." The game provides feedback to the player on their performance, such as: "when you had to feel 100% fear you showed only 0.84% fear;" "to show more empathy, try to smile 99.99% less;" and "now retry and improve." To win the game is to perform best at matching your own facial expressions which the facial expression instructed by the game.

Ruben van de Ven began his art-based research into biometrics with a question about the comparative percentages in the summary data that is produced by some recognition technologies, as with the Affectiva SDK used in *Emotion Hero*.[68] "What then does it *mean* to feel 63% surprised and 54% joyful?" he asked, according to an article that he wrote for the Institute of Network Cultures (INC) Longform in Amsterdam drawn from his master thesis.[69] Van de Ven observed how such "numbers, rather than showing the intensity of an emotion, reflect the statistical similarity with a prototypical expression, which is now established as a desired way of showing a certain feeling – whether true or feigned."[70] That is, these fractions of one hundred denoted by a percentage sign (e.g. 63% or 54%) do not express a quantity, but rather a probability. The number is not a model for how much this or that emotion is being experienced in the face of the individual whose image is being analyzed by the recognition technology (i.e. some person is 63% surprised). Rather, the number is a model

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67 *Idem*, *Emotion Hero: Game Demo*, Vimeo video, 02:08, 2017, https://vimeo.com/191263327 (accessed: 11.12.2019).

68 iMotions Biometric Research Platform, *Affectiva*, https://imotions.com/affectiva-requestdemo (accessed: 11.12.2019).

69 R. van de Ven, *Choose How You Feel…*, *op. cit.*, p. 1.

70 *Ibidem*, p. 20.

of how likely it is for a given emotion to be the emotion that is being experienced (there is a 54% chance that some person is joyful).

Through his art-based research, and the data collection and analysis conducted with *Emotion Hero*, Ruben van de Ven concluded that "the ambiguity of expressions is often ignored by developers" of recognition technology.[71] Further, Basic Emotions Theory, or "Ekman's model of seven emotions," as van de Ven put it, "is not as indisputable as its omnipresence in the various tools might suggest." This is demonstrated in *Emotion Hero*, to start with, by the fact that players, staged not spontaneous, voluntary but staged, involuntary expressions. To van de Ven, "[k]ey here is not only that the classification procedure in and of itself is flawed."[72] "[T]he main concern is that the definitions that delineate the technology are flawed." And so, with this art, the artist poses the question: "As there seems not to be a clear definition of 'emotion,' how can one know what is being measured by emotion analysis tools?"

Basic Emotions Theory, therefore, has a number of failings. There are failings in both its method and its model. These include its method for conducting experiments about the facial expression of emotion through a logic process in which subjects match a query to a template image. These also include its model for conceptualizing how the face expresses an emotion as being like how a computer executes its programming. But despite the failings by which it was established, or perhaps in fact because of them, Basic Emotions Theory provides best support for the construction of causal laws as well as common, shared, and even universal classifications.[73] Through Basic Emotions Theory, the facial expression of emotion is defined as measurable, objective, and rational. This is not because face and emotion are observed to be this way amid the phenomena of the world. Rather, as information scientist Kirsten Boehner and her colleagues illustrates, it is because emotions are experimented upon in this way during the process of becoming "studiable."[74] That is, the "definition of emotion has been altered to fit a particular conception of what science ought to be." The reality, of course, is more complex and more uncertain. But it is by such a logic that recognition technology becomes operational, as the face is digitized into a form – data – that can be processed by a machine, by a computer, and by artificial intelligence within an automated facial expression recognition system.

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71 *Ibidem*, p. 6.

72 *Ibidem*, p. 16.

73 N.H. Frijda, *The Psychologists' Point…*, *op. cit.*, p. 75.

74 K. Boehner, R. DePaula, P. Dourish, P. Sengers, *How Emotion Is Made and Measured*, "International Journal of Human-Computer Studies" 2007, Vol. 65, No. 4, p. 278, DOI: 10.1016/j.ijhcs.2006.11.016.

4. The Facial Action Coding System (FACS)

In the early twenty-first century, the basis for most, if not all, emotion recognition is the Facial Action Coding System.[75] FACS is a comprehensive, descriptive sign-based technique for the observation and measurement of all visible facial behaviors. It was designed by today's world-leading advocate for Basic Emotions Theory, American psychologist Paul Ekman, about the same time as the early researches with recognition technology in the 1970s, and first published in 1978 with a revised edition in 2002. With support in the beginning from the Advanced Research Projects Agency (ARPA), and then for forty years from the National Institute of Mental Health (NIMH), Ekman pioneered face studies with his cross-cultural analysis of the facial expression of emotion in in Brazil, Japan, and the US, as well as with uncontacted, preliterate societies in New Guinea and Borneo.[76] Over time, however, his focus shifted from creating a theory of the face to creating a technique for its measurement.

While researching and developing FACS, Ekman and his team at the Human Interaction Laboratory at the University of California San Francisco reviewed fourteen different measurement techniques that had been designed in the fifty years between the 1920s and the 1970s.[77] A fundamental problem with these "theoretically derived systems is that they cannot discover behaviors that were not posited in advance."[78] In comparison and contrast, FACS can be used for "measuring the sign vehicles that convey the message" rather than making interpretation "judgments about one or another message," and for classifying "descriptive units" rather than "inferential labels."[79] That is, FACS can be used to observe and measure "everything the face *can* do" rather than what it "*should* do according to a given theory" or concept.[80] Although FACS has all manner of applications for basic research on facial behavior, Ekman still advocates for Basic Emotions Theory. Consequently, the coding system is most frequently associated with emotion phenomena and measuring facial events that include AUs or AU combinations that have been attributed by Ekman among others to so-called Basic Emotions. Thus, research scientists Meredith Whit-

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75 P. Ekman, W.V. Friesen, J.C. Hager, *FACS Manual on CD-ROM*, Network Information Research Corporation, Salt Lake City, UT 2002.

76 P. Ekman, E.R. Sorenson, W.V. Friesen, *Pan-Cultural Elements in Facial Displays of Emotion*, "Science" 1969, Vol. 164, No. 3875, pp. 86–88, DOI: 10.1126/science.164.3875.86.

77 P. Ekman, *Methods for Measuring Facial Action*, in: *Handbook of Methods in Nonverbal Behavior Research*, eds. K.R. Scherer, P. Ekman, Cambridge University Press, Cambridge 1982, pp. 50–57.

78 E. Rosenberg, *Introduction: The Study of Spontaneous Facial Expressions in Psychology*, in: *What the Face Reveals: Basic and Applied Studies of Spontaneous Expression Using the Facial Action Coding System (FACS)*, 2nd Edition, eds. P. Ekman, E. Rosenberg, Oxford University Press, Oxford 2005, p. 14 (1st edition 1998).

79 P. Ekman, *Methods for Measuring…*, *op. cit.*, p. 46.

80 E. Rosenberg, *Introduction…*, *op. cit.*, p. 14 (emphasis in original).

taker and Kate Crawford state in the *AI Now Report 2018*, "AI researchers have taken his work as fact, and used it as a basis for automating emotion detection."[81]

One of the primary aims of FACS and FACS-based automated facial expression analysis, as contextualized and historicized by Kelly Gates, a scholar in communication and science, "is to make human affective behaviors more *calculable*, open up to precise measurement and classification, thereby making them more amenable to forms of intervention, manipulation and control."[82] By applying FACS, a coder either human or machine scores sixty-one individual Action Units. Although based on the muscular anatomy of the forty-three facial muscles, these AUs do not correspond either one-to-one to specific muscles or muscle groups. FACS supports the performance of a spatial analysis of the face, both globally with principal components, as well as locally with particular features, with the use of intensity scores for each Action Unit which are annotated by appending letters (A–E) from trace or very slight (A) to maximal or strongest possible (E). FACS also supports the performance of a temporal analysis of the face, through the observation and measurement of combinations of Action Units, or what is commonly meant by an expression, with the use of timing scores which segment the actions into their onset, apex, and offset.

The Facial Action Coding System, therefore, is an essential part of the technological subface for biometric art that is based on emotion recognition using artificial intelligence, to one degree or another.[83] And it is one material out of the many that is intermedially combined into a biometric artwork, determining its media specificity, and contributing to its signification, as in Ruben van de Ven's (NL) *Choose How You Feel* (2016), which used FACS-based Affectiva. However, FACS can also be an essential part of the technological surface for biometric art. For example, in 2019 with *Face Design* (Fig. 9), Dutch cosmetic doctor and media artist Marsha Wichers used recognition technology to create a video performance. Wichers filmed herself "making eighteen facial expressions before and after having undergone full facial [Botox] BTX injections," then analyzed these input video files, and visualized the results in an output video which she shared online.[84]

[81] M. Whittaker, K. Crawford, R. Dobbe, G. Fried, E. Kaziunas, V. Mathur, S.M. West, R. Richardson, J. Schultz, O. Schwartz, *AI Now Report 2018*, AI Now Institute and New York University, New York 2018, p. 14.

[82] K.A. Gates, *Our Biometric Future: Facial Recognition Technology and the Culture of Surveillance*, New York University Press, New York 2011, p. 22 (emphasis in original).

[83] M. Pantic, M.S. Stewart Bartlett, *Machine Analysis of Facial Expressions*, in: *Face Recognition*, ed. K. Delac, M. Grgic, I-Tech, Vienna 2007, pp. 377–416; M. Pantic, *Machine Analysis of Facial Behavior: Naturalistic and Dynamic Behavior*, "Philosophical Transactions of The Royal Society B" 2009, Vol. 364, pp. 3505–3513, DOI:10.1098/rstb.2009.0235.

[84] M. Wichers, *Face Design*, 2019, https://www.projectfacedesign.com (accessed: 11.12.2019).

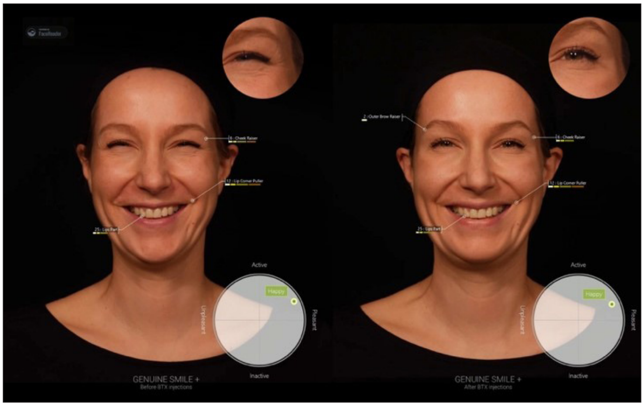

Fig. 9: Marsha Wichers, *Face Design*, 2019. (Left) genuine smile without Botox. (Right) artificial smile with Botox. Used with permission

In her own words, according to her artist statement, Wichers took a stance on how "[f]acial enhancement has almost become a commodity these days. Everybody can by full lips, Botoxed skin and re-shaped cheekbones."[85] But "[i]f we go too far in facial enhancement, our faces will start to look unnatural and may communicate in a different way." Today, more and more findings in the behavioral sciences point to "a significant decrease in the strength of emotional experience" with Botox.[86] This includes post-injection drops in facial mimicry, whereby one empathizes with someone else's emotions by simulating their expression with one's own face through enactive or mirror neurons,[87] as well as facial feedback, which serves as a channel for communication not only interindividually but also intraindividually by sending information to the brain about emotion so as to modulate and initiate emotional response.[88] Through her "design research," Wichers "wanted to gain insight into this matter because [she thinks] it is important to be aware of the side effects of our efforts to look young and beautiful."[89] And her goal with the "project *Face Design* is to raise awareness and to start a discussion about societal and ethical issues regarding facial enhancement."

85 *Ibidem*.

86 J.I. Davis, A. Senghas, F. Brandt, K.N. Ochsner, *The Effects of BOTOX Injections on Emotional Experience*, "Emotion" 2010, Vol. 10, No. 3, pp. 433–440, DOI: 10.1037/a0018690.

87 G. Rizzolatti, C. Sinigaglia, *Mirrors in the Brain: How Our Minds Share Actions and Emotions*, transl. F. Anderson, Oxford University Press, Oxford 2008, pp. 177–190. Originally published in Italian as *Specchi nel cervello: Come comprendiamo gli altri dall'interno*, Raffaello Cortina Editore, Milan 2006.

88 P. Andréasson, *Emotional Empathy, Facial Reactions, and Facial Feedback*, "Digital Comprehensive Summaries of Uppsala Dissertations from the Faculty of Social Sciences" 2010, 58, Uppsala Universitet, Uppsala, Sweden, pp. 11–14, http://www.diva-portal.org/smash/get/diva2:327146/FULLTEXT01.pdf (accessed: 11.12.2019).

89 M. Wichers, *Face Design*, *op. cit.*

As Wichers herself accounted on both the project website for *Face Design* and company blog for Noldus,[90] Botox itself is a commercial form of the botulinum toxin (BTX), a neurotoxic protein that is produced by *Clostridium botulinum* and related bacterium. When injected into the human face, BTX prevents release of the neurotransmitter acetylcholine from reaching the nerve endings at the neuromuscular junction, causing flaccid paralysis. That is, BTX blocks the signal from nerve to muscle, inhibiting muscular contraction and thereby facial movement. A few days later, facial muscles relax and facial skin smooths, resulting in the cosmetic effect of reduced facial lines and wrinkles. First used cosmetically in 1987, approved for the treatment of glabellar frown lines by the Federal Drug Administration (FDA) in 2002, and with over 1,801,033 procedures performed in 2018 alone, a 35.8% increase from 2014, Botox today is the top nonsurgical procedure in the US.[91]

In the subface of *Face Design*, Wichers used FaceReader, developed by Noldus Behavioral Science in Wageningen, the Netherlands,[92] first released in 2007, with annual updates, and distributed by VicarVision.[93] When analyzing video, either live up to twenty frames-per-second or prerecorded frame-by-frame, as with Wichers' *Face Design*, the facial recognition using artificial intelligence worked in three steps.[94] First, the system detected the presence of the artist's face in the video using the Viola-Jones algorithm. Second, it extracted over 500 points in the face and its texture, using 3D modelling and the Active Appearance Method (AAM), encompassing global position as well as the state of the eyes, eyebrows, lips, and nose which are important for classifying facial expressions. And third, the system, an artificial neural network trained with over 10,000 images manually coded by FACS experts, classified facial expressions related to the Basic Emotions anger, contempt, disgust, fear, happiness, sadness, and surprise, on the basis of Action Units from Ekman's Facial Action Coding System. Then on the surface of *Face Design*, as Wichers visualized in her online video, the output results from FaceReader as it measured the movements of her own facial morphology included the name and number for each AU, and the intensity of these facial actions on a horizontal bar graph, as well as plots for the valence of the emotion in a circumplex model with unpleasant/pleasant on the x-axis and active/inactive on the y-axis.[95]

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[90] *Eadem*, *How Botulinum Toxin Affects Facial Expression*, *Noldus Behavioral Research Blog*, 25.02.2019, https://www.noldus.com/blog/how-botulinum-toxin-affects-facial-expression (accessed: 11.12.2019).

[91] American Society for Aesthetic Plastic Surgery (ASAPS), *Cosmetic (Aesthetic) Surgery National Data Bank Statistics 2018*, pp. 4, 6, https://www.surgery.org/sites/default/files/ASAPS-Stats2018.pdf (accessed: 11.12.2019).

[92] Noldus, *FaceReader*, n.d., https://www.noldus.com/facereader (accessed: 11.12.2019).

[93] VicarVision, *FaceReader*, n.d., http://www.vicarvision.nl/products/facereader/ (accessed: 11.12.2019).

[94] L. Loijens, O. Krips, *FaceReader Methodology Note*, white paper, Noldus Information Technology, 2019, https://www.noldus.com/facereader/resources (accessed: 11.12.2019).

[95] J.A. Russell, *A Circumplex Model of Affect*, "Journal of Personality and Social Psychology" 1980, Vol. 39, No. 6, pp. 1161–1178, DOI: 10.1037/h0077714.

Through *Face Design*, Wichers found that it is difficult "to show anger when you can't frown, or disgust when you can't depress the corners of your mouth."[96] Further, she concluded that due to the "paralyzing effect of botulinum toxin, the muscles around the eyes cannot contract. It is giving you less wrinkles but also takes away your 'real smile'." Wichers had "self-fired" or "voluntarily activated"[97] her own facial muscles in what is popularly known as a smile, wherein the *orbicularis oculi, pars lateralis* constricts laterally, raising the infraorbital triangle, lifting the cheeks, and gathering the skin medially toward the eye socket from around its lateral edge, and the *zygomatic major* facial muscles contract posteriorly and superiorly, pulling the lip corners upwards. Using Ekman's FACS and Noldus' FaceReader to perform self-recognition on her own face, Wichers then classified this facial event as AU6+12 or a combination of AU6, the Cheek Raiser, and AU12, the Lip Corner Puller. In Ekman's face coding, the Cheek Raiser, which at stronger intensities causes crow's feet or skin bagging and wrinkling that extends radially from the eye aperture, distinguishes a smile of happiness or so-called "Duchenne smile."[98] But while "in human perception, this feature makes a very important difference between a real or genuine smile and a fake smile," in Wichers' *Face Design*, computer vision "fails to detect the absence of contraction around the eye, and rates both expressions as happy."

Of course, the face has long been used in society for putting people into boxes made from diagnoses, labels, or symptoms, as well as to constrain or even determine potential interpretations for their behavior through the attribution of causal laws and the assignment of universal classifications. Now emotion recognition "promises a type of emotional weather forecasting."[99] The "idea that AI systems might be able to tell us what a student, a customer, or a criminal suspect is really feeling or what type of person they intrinsically are is proving attractive to both corporations and governments," despite the fact that "the scientific justifications for such claims are highly questionable, and the history of their discriminatory purposes well-documented." Yet, the formal design for recognition technology may employ many logical fallacies from physiognomic inference, such as presuming a stable binary or one-to-one correspondence between facial behavior and emotion phenomena.[100]

96 M. Wichers, *Face Design*, *op. cit.*

97 W.E. Rinn, *The Neuropsychology of Facial Expression…*, *op. cit.*, pp. 12–17.

98 P. Ekman, R.J. Davidson, W.V. Friesen, *The Duchenne Smile: Emotional Expression and Brain Physiology II*, "Journal of Personality and Social Psychology" 1990, Vol. 58, No. 2, pp. 342–253, DOI: 10.1037/0022-3514.58.2.342. The "Duchenne smile" is named after French neurologist Guillaume-Benjamin Duchenne de Boulogne, who first reported the facial action, and whose photographs Darwin included in his *Expression*.

99 M. Whittaker *et al.*, *AI Now Report…*, *op. cit.*, p. 14.

100 G. Boys-Stones, *Physiognomy and Ancient Psychological Theory*, in: *Seeing the Face, Seeing the Soul: Polemon's* Physiognomy *from Classical Antiquity to Medieval Islam*, ed. S. Swain, Oxford University Press, Oxford 2007, p. 40.

Conclusion

Principally, the way recognition technology works is through a process of “facialization,” to borrow a term from philosophers Gilles Deleuze and Félix Guattari,[101] which translates the face into higher and higher degrees of abstraction, from a subject of corporeal flesh to an object of scientific calculus. This process “deterretorializes” facial signs away from and out of their organic context and semiotic niche. And it over codes faceness or “faciality” as experienced and lived with an artificial mask. Employing much of the same logic as classical physiognomy, current biometrics is primarily used to make sensible the outside physiological behaviors of the face, in order to make cognizable the psychological phenomena inside of an individual, by computing a person inside out into data that is operational and utilitarian, quantifiable and universal.[102]

Today, facial recognition using artificial intelligence has two main areas of application. The first is identification, done mostly on the basis of the static face from still photographs, and used to make physiological data sensible in face morphology, such as on age, ethnicity, gender, and identity. The second is analysis, done mostly on the basis of the dynamic face from motion pictures, and used to make psychological data cognizeable in face movement, such as on attention, cognition, emotion, intention, and pain. For each application, the classifier that a face is compared to and matched with, whether from the Facial Action Coding System or Basic Emotions Theory, affords for different understandings of what the face is and what it does.

Biometric art which uses facial recognition and emotion recognition is neither an art genre nor an artistic movement (-ism). And neither is it a place of study nor a school of thought. Rather, such biometric art is a contemporary art form in which an artist experiment with the way recognition technology works as an instrument or tool for artistic creation. It is a critical practice with specificity and value which provokes de-automizations and re-negotiations with other human practices, such as facial recognition and emotion recognition. Through its dynamic intersections with these sciences and technologies, biometric art in turn is constitutively entangled with the interpretive processes of a meta-critical reflection. In so doing, biometric art ruptures our everyday habitual and lived experience of the face, revealing the ways in which facial recognition technology and automated facial expression analysis may affect our dispositions, beliefs, and attitudes towards facial behavior and emotion phenom-

[101] G. Deleuze, F. Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia*, transl. B. Massumi, University of Minnesota Press, Minneapolis, MN 1998, pp. 168–172. Originally published in French as *Capitalisme et Schizophrénie 2: Mille Plateaux*, Les Éditions de Minuit, Paris 1980.

[102] The phrase “inside out” appearss in the titles for P. Ekman, *Emotions Inside Out: 130 Years After Darwin’s “The Expression of the Emotions in Man and Animals”*, “Annals of the New York Academy of Sciences”, Vol. 1000, New York Academy of Sciences, as well as the Pixar/Disney film *Inside Out*, directed by Peter Docter, for which Ekman served as scientific advisor, and which won the 2015 Academy Award for Best Animated Feature.

ena, how we think about what we feel, and the very nature of "face consciousness."[103] Consequently, biometric art is an intellectual and ethical activity. It affords for the conceptual models by which people are classified, computed, and even controlled on the basis of face to be made, manipulated, talked about, and tested across the socio-political imaginary. And across highly diverse art forms, some of this biometric art plays with facial recognition technology, some subverts; some celebrates the accomplishment, some critiques the arrogance; some puts it on stage, some on trial.

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[103] A. Wilkins, *Making Faces…*, *op. cit.*, p. 307.

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