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ABSTRACT

Rapid changes in science, technology and new media will lead to more sophisticated ideas about what it means to be human, in thought, body, emotional response and artistic expression. New relationships will form between humans, machines and animals with the human functioning as a networked resource that can be accessed globally over the internet.

This paper documents both the technical and theoretical development of the collaborative interactive new media video project "The Emotions (after Charles Darwin)" which explores some of the above concepts. "The Emotions" first tries to establish the existence of the universality of emotions at a biological level, as empirically measured and documented by the results of the control group (non-autistic subjects, as the goal is to document "normal", i.e. universal emotional response) at the Brain Mind Institute in Switzerland. Secondly, it suggests the potential for subsequent futuristic misuse through genetic and or technological modification (demonstrated by the observer's ability to interactively modify or transform a given emotion's video stream at will).

Keywords

Cognitive and computational neuroscience, embodiment, bioethics, emotions, interactivity, Plutchik, amygdala, face perception.

1. INTRODUCTION

Although Darwin was incredibly prescient in his discoveries about what role the nervous system might play in regulating emotions, developments in neuroscience did not begin until well over a 100 years later, partially due to the lack of sophisticated recording and analytical tools such as neuro-imaging and computation made easier, enhanced through software algorithms and applications executed on computers.

This co-mingling of previously unrelated and seldom overlapping disciplines means that new media itself, its practices, applications and theories will continue to be in constant flux and development. It used to be standard practice in beginning art classes to ask what is art? But now the question is not only what is art, but who or what makes art (i.e., sometimes art now takes on a life of its own, extending beyond the control of its creator).

For example, the interactive new media video project "The Emotions (after Charles Darwin)" attempts to prove the universality of emotions by transcending cultural categorizations such as species, race, age and gender and instead relates emotions to their neurobiological origins and functions. It further suggests that once empirically known, that this information can be used to

genetically or technologically alter human emotion(s) in individuals or groups to create new beings or new emotional interiors that better conform to culturally desirable behaviors. This of course raises bioethical questions about the future nature of life for humans and animals; the embodiment and containment of the self and its symbiotic integration and enhancement with technology and machines.

"No Longer is human existence defined by its unique temporal and spatial coordinate; one body, one life in a specific space and time. Instead human life is increasingly defined by the agential, instrumental deployment of resources for bodily renewal, both its temporal and spatial context subject to extensions or translocations", according to Susan Merrill Squier, in *Liminal Lives: Imagining the Human at the Frontiers of Biomedicine*.

As Joanna Zylinska states in her book *Bioethics in the Age of New Media,* "This is by no means to suggest that the human has been reduced to information in the age of new media and that we can therefore do away with embodiment; it is only to point to the emergence of new discourses of the human which undermines its centering around some fixed biological characteristics or moral values."

She adds, "The human does not disappear from the kind of nonhumanist bioethics envisaged here: in fact, it functions as its strategic point of entry. What we are dealing with, however, is not so much a "human being" understood as a discrete and disembodied moral unity but rather a "human becoming"; relational, co-emerging with technology, materially implicated in sociocultural networks, and kin to other life forms."

Neil Badmington in *Alien Chic* talks about how recent trends in techno-science have unsettled post humanist critics. For example he talks about how Donna Haraway's "Cyborg Manifesto (1991)" first deconstructed humanist relationships such as organism/machine, reality/fiction/human/animal, physical/non-physical and self/other and replaced them with chimeras; cyborgian fabrications of machine and organisms. He goes on to say that the latest trend in post-humanism seems to involve merging with animals, which ironically was not a concept alien to Darwin 140 years ago when he studied, documented and sought to define similarities with animals' emotions and our own.

Badmington quotes numerous television and news reportage from *Newsweek* to *Nature*, who discovered that reason, tool use, tool making, altruism and language are not unique to humans, neither I might add, is making or performing music (last year I presented

Digital Arts and Culture, December 12–15, 2009, Irvine, California, USA.

"Birdsongs; the Language Gene", in the "Sonic Fragments Soundart Festival" at Princeton University which digitally reconfigures bird songs into human music).

2. DARWIN AND NEUROSCIENCE

Over a hundred years ago, Charles Darwin theorized that the universality of emotions existed in humans and animals at a biological level. He posed questions such as can we feel happy, sad or fearful when we are alone or are emotions a unique result of being with others in a social situation? He suggested that the reason for the universality of emotions was due to an underlying biological basis that communicated our needs to others. We experience an emotion and specific areas of the brain send signals to specialized muscle groups that respond to communicate our feelings.

Darwin believed that the following principles were responsible for most of the expressions and gestures involuntarily exhibited by humans and animals while experiencing emotions: habitual actions initiated by certain states of mind in order to relieve or gratify certain sensations, habitual inverse actions initiated by the exact opposite states of mind and actions initiated by the nervous system mostly independent from both will and habit.

In post Darwin times, scientists study what regions and chemicals in the brain control different emotions and if these regulators can be modified to elicit alternative results. For example, emotions are studied to determine their affect on the immune, cardiovascular and endocrine systems. There is also the possibility for misuse, what if we could invoke certain emotions in people at will through a drug or by permanently or temporarily altering structures in their brain? Perhaps at the same time we could remove their ability to feel remorse or guilt. Could this form of genetic intervention be used randomly against individuals or during war-time to induce people to commit violent acts?

The neuroscientist Joseph Ledoux says the brain has not evolved to the point where connectivity exists for cognitive systems to control our emotions. But even so, he says that wouldn't necessarily be good, because Mr. Spock (a character lacking in human emotions from the 60's TV show Star Trek) may not be an ideal kind of human that we'd like to become. Additionally, Ledoux talks about futuristically controlling undesirable emotions such as fear through drug regulation, stating that once we can identify the neurotransmitters that are involved in producing fear, we could create a chemical profile of fear in the amygdala and then develop a drug to attack it.

The amygdala is an almond-shaped structure in the frontal portion of the temporal lobe near the hippocampus in the brain that allows us to both feel and perceive negative emotions. It regulates our reactions to events that are important for survival such as the presence of danger, sexual partners, enemies, food and those in need. The amygdala works as a system with other related structures because unique sets of regions in the brain are connected to each other and work together to control different emotions. It also plays an important role in emotional regulation and studies have shown that emotional disorders can manifest themselves both functionally and structurally (it can become asymmetrically enlarged in depressed individuals). Patients who have had their amygdala destroyed due to stroke are able to recognize all emotions expressed by facial expressions except for fear.

The amygdala's connectivity with the neo-cortex is also not symmetrical; the amygdala's connection to the neo-cortex is much stronger than the neo-cortex's connection to it (as shown in David Amaral's studies of primate brains), which in part explains, according to neuroscientist Joseph Ledoux, why emotions are often hard to turn off once initiated. The body also releases hormones and long acting substances at the exact time that we experience strong emotions. Additionally, there is a relationship between the visual system and emotions. In *The Expressions of the Emotions in Man and Animals*, Darwin talks about the importance of visual cues when seeking mates, prey and avoiding danger, therefore it's not surprising that studies show that the visual cortex is more activated in response to visual emotional stimuli than visual non-emotional stimuli.

Darwin acknowledged individual variance in emotional reactivity due to differences in development (for example he noticed that insane persons had strong passions which they openly expressed). But he never addressed the idea of emotion regulation which didn't come into being until the development of neuroscience a hundred years later.

Davidson defines the study of individual differences in emotional reactivity and emotion regulation as affective style consisting of the threshold to respond, the magnitude of the response, the rise time to the peak of the response, the recovery function of the response and the duration of the response. The duration of emotional responding is important in understanding individual differences and can also indicate psychopathology since some mood disorders are associated with either an abnormally early onset or inability to turn off a response quickly enough.

3. THE EMOTIONS

"The Emotions" is a multi- channel interactive video where each of four panels will display close-up graphic, moving images of men, women and children of all ages and races, expressing a specific emotion such as happiness, sadness, fear or anger (categorized as such by the results of the control group). Each panel's images will morph/blend to form a continuous stream of soundless images whose emotion will not be identified so as to allow the viewer the ability to form their own conclusion as to what emotion they feel is being expressed (which will also test the universality of emotions).

A fifth panel will record live audience reaction/ participation at the actual site of the installation in order to test mirroring behavior of the emotions displayed in the other four panels. Additionally the observer will have the ability to interactively modify, convert or morph emotions; demonstrating a futuristic ability to alter emotions genetically and or technologically at will. "The Emotions" is a collaboration with the Brain Mind Institute in Switzerland whose experiments done using my photographs validates their universality as images of specific emotions and forms the basis for the video.

Shortly after "The Emotions" was accepted into the New Media Collection (Rhizome) at the New Museum, I was contacted by Britt Russo, a neuroscientist who had seen the project posted on their web-site. She asked me if I would be interested in collaborating with her lab at the Brain Mind Institute in Switzerland and would allow them to use my photographs for emotion perception research in autistic subjects. The lab had never used photographs from life before, only those of staged actors. In return they would present my work at international meetings and publish it in scientific journals. Although the lab wanted to use my photographs for research in autism; a neurodevelopmental disorder that impairs social functioning, I knew I would be primarily interested in the results of the control group as I wanted to document what was perceived as "normal" or "neurotypical" response and therefore universal, not the responses evidenced solely in autistic patients. However I thought that I might learn more about emotional response in general; its measurement and analysis by including the observation of autistic patients since I had the opportunity.

At the first meeting I had with Britt in Manhattan in the third week of December 2007, she informed me about the institute and its practices. The Brain Mind Institute was considered a world-class research facility for neuroscience whose goal was to synthesize and create a knowledge base by advocating a multidisciplinary approach across disciplines and by linking different research laboratories.

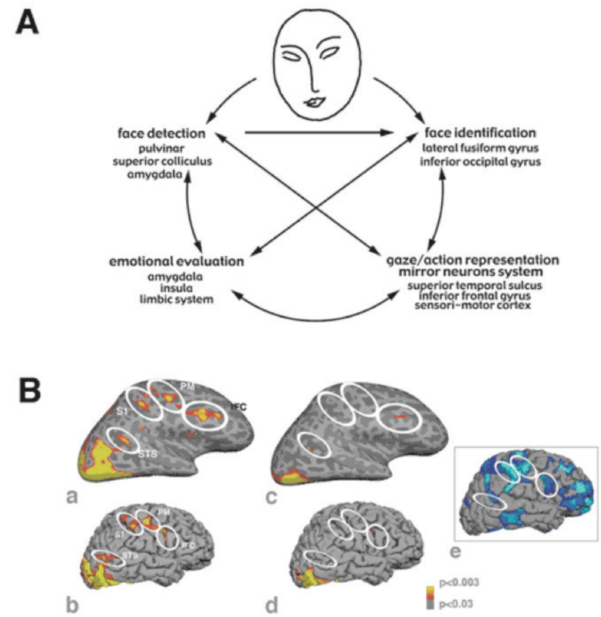
As taken from their web-site: "The mission of the Brain Mind Institute is to understand the fundamental principles of brain function in health and disease, by using and developing unique experimental, theoretical, technological and computational approaches. The scientific challenge addressed by the BMI consists in connecting different levels of analysis of brain activity, such that cognitive functions can be understood as a manifestation of specific brain processes; specific brain processes as emerging from the collective activity of thousands of cells and synapses; synaptic and neuronal activity in turn as emerging properties of the biophysical and molecular mechanisms of cellular compartments." The group that I would be working with was headed by Dr. Nouchine Hadjikhani; a specialist in neuroimaging.

3.1 Testing at the BMI Lab

In the lab, functional magnetic resonance imaging (fMRI), Electroencephalography (EEG) and magnetoencephalography MEG) were used to visualize brain activity and electromyography (EMG) was used to measure facial muscle activity of autistic subjects while they viewed images of human emotional facial expressions (autistic people display different brain activity patterns and facial muscles reactions than normal or "neurotypical" people). A Tobii eye tracker was used to trace the path of the subject's eyes, while they viewed images.

According to Dr Hadjikhani's research, autism was thought to be related to the dysfunction of the mirror neuron system that plays a critical role in the perception of other people's intentions including empathy. Autism Spectrum Disorder (ASD) is a behaviorally defined neurodevelopmental disorder of early onset whose subjects suffer from a social disability that profoundly affects their ability to understand other people's feeling and to establish reciprocal rewarding relationships. The disorder manifests itself by exhibiting restrictive and or repetitive interests and behaviors. Persons suffering with ASD typically fail to engage in social interactions because of an inability to correctly interpret facial expressions and their meanings. Abnormalities in face perception (crucial to social-communicative competence) and the accurate identification of the deficient components of the face processing system are essential to the understanding of ASD.

The lab's primary area of study was the functional and structural integrity of the social cognition network as it relates to autism and also the amygdalas's connectivity to the mirror neuron system (Figure 1).



A. Elements of the network exert reciprocal influences on each other. Face processing deficits can arise from the dysfunction of one or more elements of the network and to or from each element's termination point.

B. During face perception, the face identification system is activated in both healthy controls and in individuals with ASD when cued to look at the eye-region. However, face perception also activates areas of the MNS (see a and b) in healthy controls but these same areas remain quasi silent (see c and d) and exhibit a thinner cortex (see e) in individuals with ASD. The face processing difficulties exhibited by ASD individuals could be due to the dysfunction of the MNS.

Figure 1. Social Cognition Network

In summary, the lab's studies showed cortical thinning of the mirror neurons system and an abnormal recruitment of mirror neurons areas during face perception as well as abnormal temporal activity in face-processing areas. They had also disproved a popular theory that said that autistic patients were lacking in the brain area devoted to face identification, opening up new therapeutic strategies and areas of inquiry.

3.2 Image Preparation

Britt sent me instructions on how I needed to prepare the photographic images for the MRI scanner experiments (Figure 2) to be performed by the autistic subjects and the control group (I would later extract the results of the control group and use them for my video). The goal was to make the photographs neutral and uniform in appearance, displayed with minimal luminance and no distracting background elements.

Each image was cropped from the hairline to the chin and formatted so that the eyes were always in the center of each photograph, therefore the autistic person did not have to move their eyes in order to focus on a red fixation cross while in the MRI scanner. Dr. Hadjikhani had discovered that by placing a red fixation cross in the center of each image and telling the subjects to focus on it while in the scanner that the fusiform face area was activated in autistic brains, just like it was activated in non-autistics. Earlier studies had failed to show activation of the face area in autistics probably because they weren't actually looking at the faces in the photographs.

The lab at first wanted me to mask out the backgrounds but then decided that they wanted to test (using an eye tracker) what part of the photograph the autistic person spent more time looking at; the faces or the backgrounds. Previous studies had found that autistic persons spent more time looking at backgrounds than at faces in photographs. They also performed experiments comparing responses to the staged photos of actors used by the lab with my photographs from life using magnetoencephalography (MEG) to visualize brain activity.

I adapted a lot of the lab's methodology not only in the way I prepared images for their experiments but also how I planned to later group (according to the results of the control group), animate and display them in the video. I wanted my images to appear as objective and scientific as possible. For example, I also centered

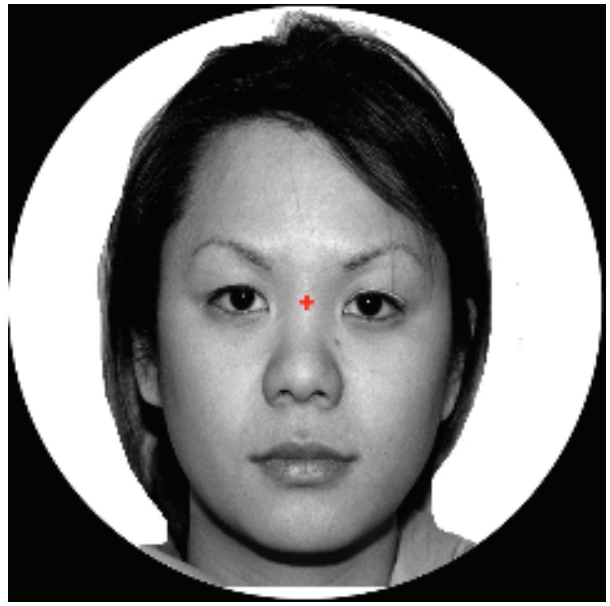


Figure 2. Modified photo for fMRI experiments

Luminance could be contained by creating an adjustment layer in Photoshop. I planned to import the photos as an image sequence into Photoshop Extended and convert the images to video layers in order to edit them. I also created and applied displacement and particle maps in Photoshop and After Effects to create subtle movements and blending from one image to another and outputted the files to Flash in order to create behaviors for looping of the four separate videos. For the fifth channel I planned to hook up a digital camcorder to a projector to capture possible mirroring behavior and to also allow observers to interactively modify, convert or morph emotions.

Figure 3. Color-coded Schematic for "The Emotions"

the eyes in the images but instead of completely masking out the background in my photos as the lab did, I achieved a similar but more naturalistic affect by tightly cropping the images and minimizing any unwanted background distractions.

I sent Britt a color-coded schematic of what I envisioned for 4 channels of my video consisting of the emotions happy, angry, surprise and sad. I wanted to relate each photograph graphically and logically to a specific emotion (Figure 3).

3.3 Plutchik's Emotional Index

The lab typically used black and white photos for their testing but decided to use my color images in an eye tracking experiment. They could then later convert them to black and white and flatten the luminance if needed (as previously shown to be necessary in early eye-tracking experiments) if the autistic subjects were distracted by the glare unavoidably caused by high-contrast lighting situations.

Britt sent me a schematic representation of Plutchik's color-coded "Emotional Index" which was comprised of eight basic emotions and their increasingly less intense variations (Figure 4). She had the control group categorize each photo by choosing one of the words from the entire diagram instead of just limiting them to one of the eight basic emotions because she thought that would generate a more accurate rating given the subtlety of some of the photographs that I sent her.

After the Plutchik test, an eye tracking pupillometry study would then be conducted on the control group subjects to systematically rate each photo by its emotional intensity; from bad through neutral through good. I could then select images by emotion and or emotional intensity to be used in the video. For example I could select faces that were rated high intensity (terror), medium intensity (fear) or low intensity (apprehension). Additionally by using Plutchik's Schematic I could relate each emotion for the video not just by emotional category and or intensity but also by its associative symbolic color as it appeared on the chart.

According to *The Handbook of Psychological Testing* by Paul Kline, Plutchik's Emotional Profile Index is based on eight basic emotions which are joy, acceptance, surprise, fear, sadness, disgust, expectation and anger. Individuals choose from pairs of personality traits that describe them and each trait results from combining two or more primary emotions (i.e, shyness implies fear; gloominess implies sadness). The results are then plotted on a circumplex arranged according to similarities and bipolarities.

A fMRI study was performed after rating the photographs by emotional intensity. Other considerations were evaluating direct verses indirect gaze, group make up and image order. The lab administered Oxytocin and using the eyetracker, found that Oxytocin reduced the activation of the amygdala while viewing photos of direct gazes, from neutral unfamiliar faces. This enabled the participants to feel more relaxed; which increased their amount of direct eye contact. In previous studies (Guastella, Mitchell and Dadds, 2007) Oxytocin was shown to greatly increase gaze enhancement to the eye region (the focal point for emotion, threat and interpersonal interest) which enabled participants to better detect emotions in others.

The lab sorted my photographs into direct and averted gaze because the brain responds more dramatically to direct gazes than averted ones. They were also grouped into children and adults. Two sets of images were created (so the lab could experiment with the same group of subjects but use a fresh set of faces) that were balanced in terms of age, sex, emotion and intensity.

A small pilot study was conducted to look at the possible effects of image order on each subject's ratings. If presented one at a time, then ratings could be unduly influenced by the previously presented photo, for example, a mildly sad photo following an intensely happy one might be thought of as more intensely sad than it would be if presented by itself. If this proved to be the case, an entire set of photographs could instead be presented simultaneously, and each subject would be asked to rate individual photos relative to each other. There were disadvantages to this method but at least the lab would have a whole set of photographs that would be internally consistent.

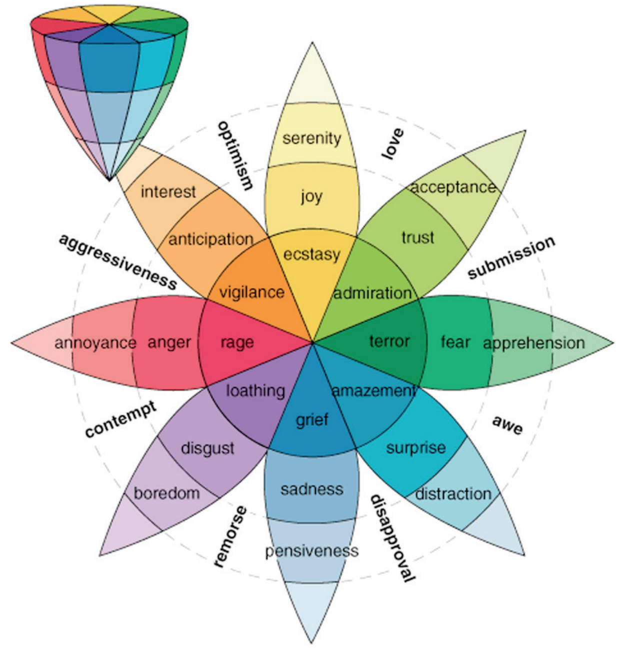


Figure 4. Plutchik's Emotional Index

The order in which the photographs were presented was found to affect a perceived emotion's intensity. I would make the video accordingly, being careful to place photographs with similar ranked emotions and intensity ratings together contained within an individual video channel, which would have the affect of displaying a group of related photos simultaneously as described in the pilot study.

Additionally the lab was thinking of adding a self-recognition test into the protocol (it has been suggested that autistics have self face recognition deficits) by randomly inserting photos of the subject brought in from home and also by presenting new ones that the lab would take themselves but that the subject wouldn't see before the experiment.

The idea of the self recognition test reinforced my idea about including a 5th interactive "self-recognition" video channel (by hooking up a digital camcorder to a projector at the exhibition site) to record live emotional reaction including possible mirroring behavior and to allow the participant to be part of the experiment. Additionally the observer would have the ability to interactively "intensity, convert or morph emotions"; demonstrating a futuristic ability to modify emotions genetically and or technologically at will.

The "Intensify Emotion" command would use a slider to make emotions appear more intense. This would be achieved by interactively applying behaviors/animations globally to a specified video stream by using After Effects/Premiere/Flash software (animations would be achieved by creating frame by frame parent/child relationships affecting the eye and mouth regions).

"Morph Emotions" would utilize a program/behaviors that would scramble all channels simultaneously by selecting and replacing video content from each of the four channels at random. "Convert Emotion" would allow the user to morph any stream of emotions into another by utilizing a program/behaviors that would select and replace video content from one video stream to another. The original color filter associated with Plutchik's color coded schematic would be applied to the new video stream, maintaining its original Emotional Index categorization reference point.

The lab decided to organize an open-house of talks and presentations for the public to celebrate the first World Autism Day on April 2, 2008, as instituted by the U.N. They teamed up with two other autism labs, one that worked with rats and other with robots. They hoped that it would generate more research subjects and also enlighten the public about autism. The lab's areas of research (including the brain areas studied) and my collaborative role are graphically summarized in Figure 5.

Figure 5. Hadjikhani Autism Lab

4. CONCLUSION AND FUTURE WORK

We finished corresponding in the summer of 2008, as the research was completed and my photographic images were categorized and documented by the control group. Throughout our correspondence, I had Britt send me any relevant documentation on what her group under Dr. Hadjikhani was researching; the technological and computational tools used to both measure and record experiments and their theoretical methods, applications and implications. The photographs that I submitted to Britt were spontaneous photos from life, never posed and taken well before I had ever thought of doing the project (so I never associated any of them with a particular emotion). They were pretty objective, the only issue being that the person being photographed was sometimes briefly aware of my presence (the lab previously used only staged photographs by actors for their testing).

In conclusion the interactive new media project "The Emotions (after Charles Darwin)"; a multi-channel interactive video consisting of multiple panels displaying close-up graphic, moving images of men, women and children of all ages and races, each expressing a specific emotion such as happiness, sadness, fear or anger (as categorized by the results of the control group) supported Darwin's ideas about the universality of emotions on a biological level.

A strong relationship was shown to exist between the control group's rating and ranking of each image's emotion (as determined by Plutchik's Emotional Index) and emotional intensity as determined by the battery of tests including pupillometry eyetracking after Oxytocin administration, functional magnetic resonance imaging (fMRI), Electroencephalography (EEG) and magnetoencephalography (MEG) to visualize brain activity and electromyography (EMG) to measure facial muscle activity.

So far emotions appear to be universal at a biological level which futuristically suggests that now that we know that, how can we modify them to elicit more desirable behaviors? Does the intensification, conversion and morphing (induced by the application of random software behaviors) of universal scientifically determined emotions used in this project bring up suggestive ideas about genetic and technological modifications of emotion regulation of the future?

Ongoing work would include the exploration and visual interactive representation of emotion regulation and control through the implementation of one or a combination of drugs, genetics or technological enhancements.

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