Decoding Racism: On Fear, Genetics, and the Duality of Human Nature

Racism has long been a painful part of the human experience, from slavery and genocides throughout history, to the institutionalized caste system in India. Today, many desire to live in a post-racial society, but we face heavy histories and shame and confusion about our own natures.

Before we begin decoding racism, let's start with a working definition. In the individual human, it's a snap judgment based on race leading to violence. In a society, it can become institutionalized into segregation and in the extreme, race-based slavery; not only just denial of resources, but denial of freedom and life.

It is the epitome of non-compassion, a deadness to the suffering of others. How do we go from innocent children to taking pleasure in violently lashing and killing another human being?

On Duality: Scarcity and Collaboration

Taking many steps back from the present, life was once a collection of barely multi-cellular organisms swarming around seeking energy to complete metabolic functions. These organisms are the precursors of our own DNA. Without energy, these organisms would die.

This scarcity has been the backbone of our evolution into a human species. We compete for survival, against other animals, working both with our fellow man and against him. We love, and we murder. We share, and we steal. We welcome, and we shun.

As humans, we exist on this earth in duality. A mixing of yin and yang, dark and light, of hot and cold. Denying the existence of either extreme is a denial of ourselves, a seesaw without the other end. We can't exist.

On Fear: Racism Begins Underneath Awareness

Why would a police officer mistakenly shoot an unarmed black man? If you ask the officer he might not even know. In seeking answers, science comes to our aide, showing that racism is deeply rooted in our minds beyond our own awareness.

In a 2004 study, 13 white students who were proven to be consciously unprejudiced were subliminally shown black faces, quickly flashed for under 0.3 seconds, underneath conscious awareness. The part of their brains that control fear, the amygdala was activated. However, when shown the image for 0.525 seconds, barely long enough to be aware, the fear response was inhibited.

In the case of police actions, where life and death decisions are made in under a second, the slightest presence of racism may be enough to tip the scales so that 5x more unarmed black men are killed than unarmed white men. The study shows, though, that just because we experience race-based fear, doesn't mean that we must act on it. It begs the question, where does this fear come from?

On Confirmation Bias: Racism Has Inertia

Our genes code for survival against scarcity using pleasure to encourage reproduction and pain to discourage life-ending behavior. With the dichotomy of pleasure and pain, our bodies experience pain; our emotions react with fear; our minds react to fear with memory and bias.

Our memories become heavy over time with inertia, grooved into our minds like a deep river. We have well-documented confirmation bias: once our minds are set they are hard to change.

We form thoughts and biases in two ways: the first from direct experience, the second from storytelling and culture. This means that just by hearing one story from Donald Trump about how Mexicans are rapists, an initial bias is set. The more I hear the story, the heavier the bias - the harder it is to change my mind. This means that a fear can spread from generation to generation, with no direct experience, only through stories, advertising, and art - the things that make up culture.

Cultural Genetics and DNA

Through culture, stories propagate themselves like genes do. They mutate and spread from generation to generation, and they feed off of emotion, a social energy, the same way that DNA feeds off of energy for survival and replication.

Where our genes end and our culture begins is an age-old question, one that has not yet been answered by science. As we enter an era of genetic engineering, it's important to consider what effects this will have.

Up Next Week: Trends in Genetic Engineering

Understand the trends, research, technology and business in genetic engineering and what it means for us.

(1/4) Trends in Genetic Engineering Volume 1, Series 2-1, Trends

Building the Staircase of Life: Farmers Were the First Genetic Engineers

We've been genetically engineering for over 10,000 years, taking advantage of random genetic mutations and exerting human selection in agriculture. Only in the last 50 years have we developed the tools to exert greater control and speed onto the process.

With a technique discovered in the 1970s and reliably patented just this year, we can now cut and past DNA, albeit still with very high error rates. You definitely would not want to try designing your baby - at least not yet.

Outside of science fiction and in real time, the market is now making rapid advancements in gene therapies for cancer and diseases like cystic fibrosis.

The Original Genetic Engineers: Ancient Farmers

Before we knew that genes were made of deoxyribose nucleic acid (DNA), ancient farmers already knew the concept of genes. In Mexico, for example, they knew that if they planted the seeds of the most fruitful teosinte grain, a type of grass with barely more seed than the grass that grows in your lawn, the grains would over several growing cycles get larger - and larger - until the Aztec society was dependent on maize (corn).

Not to mention that your puppy Fido has also been genetically engineered by human selection. Originally descended from the Asian wolf, aggressive pups were culled (killed) and docile pups were bred - leading to our 300 breeds of our modern day dog, ranging from Great Danes to chihuahuas.

So What Are Genes, Anyway?

The code that makes us up are made of 4 molecules represented by the letters: G, A, T, and C. These molecules form a helical structure.

Imagine a spiral staircase 750,000 miles long, tied in knots around itself, wrapping around the Earth 5 times. Every time a new cell is created, a new staircase must be built.

In order to create the proteins that make life, a man has to go step-by-step on the staircase - each step being one letter of the very long recipe that creates a specific life. Some parts of the staircase are so treacherous and knotted that the man jumps off and skips to the next part, leaving many portions of the recipe unread.

Each human has 5 billion +/- 5 million steps in their staircase (called **nucleotides** in DNA language). That's a huge range between individual humans, meaning that your neighbor might have 10 million more or fewer nucleotides than you do!

What does this code even do anyway? Does having more of less of it make you less of a human? It turns out that only 5% of our DNA actually codes for proteins, the essential ingredients of life.

The purpose of the rest is a mystery to science. Although this "junk" code is what makes familial DNA tests possible. The endless repetitive patterns in the junk code are very accurate at telling us where we came from, even from many generations ago.

Genetic Engineering Today: Gene Therapies

Over our lives, our DNA changes and mutates in the process of aging. Our bodies are very protective of our genes, and our immune system exists to detect and destroy any items that don't belong, like viruses or bacteria.

Some people's genes cause disease though, like the BRCA1/2 genes that are highly linked to breast cancer. In many cases of cancer, there is a gene that either causes greater incidence of genetic mutations or allows mutated genes to replicate wildly and out of control into tumors.

In order to bypass the body's natural defense and DNA-repair system, scientists use vectors, Trojan horses that sneak in therapeutic DNA past the defensive walls.

Viruses are common vectors (you'll hear the term **viral vector** a lot). Some therapies today use a modified version of the AIDS virus to inject genetic information, it's like a cellular needle.

Another method is by extracting our own stem cells, the "blank slate" cells which can become almost anything. The problem with this therapy is that stem cells are hard to find in an adult human, found usually in the bone marrow or roots of your teeth - two places where we really don't want doctors to go!

Up Next: Research in Genetic Engineering

Next week we will discuss the research behind Lamarckian evolution: **epigenetics**, the science of gene regulation.

The Low-Down on Gene Editing: CRISPR and Gene Regulation

If you're into the biosciences, you've heard about CRISPR. **C**lustered **r**egularly **i**nterspaced **s**hort **p**alindromic **r**epeats (CRISPR) and its Cas9 nucleases were discovered as part of bacterial immune systems in the 1970s; only in 2012 were they refined into a powerful gene-editing technology.

CRISPR/Cas9 is the new kid on the block, in company with a small list of gene editing techniques such as zinc finger nucleases (ZFN) and transcription activator-like effector nucleases (TALENS) which have been around since 1998 and 2009, respectively. What makes CRISPR special is that it's more highly targeted, cheaper, and computer-friendly. You can order a guide RNA (gRNA), the crucial code snippet for gene targeting, online.

While the technology works well for unicellular bacteria, it is not very effective in complex mammalian cells. By tweaking the software and hardware of this technology, scientists hope to make gains in controlled gene-editing.

Bacterial and Human Cells

Long before complex multi-cellular organisms like humans were in the picture, single-celled bacteria were our planet's dominant form of life. These bacteria competed and formed alliances with each other, and fought to protect themselves from viral invaders 1/100th their size - and bacteria are microscopic to begin with.

These viral invaders are short snippets of genetic material that cannot replicate on their own. They need a host to survive, so they sneak through the cell walls of bacteria and inject themselves into its genetic code, creating more of itself. Pretty smart.

CRISPR came from nature's own toolbox. Eventually, bacteria developed an immune system. It could absorb and remember the invader's genetic code, so that the next time the virus came around, the bacteria could send a nuclease after it, cutting the virus into useless bits. Even smarter.

CRISPR Trick #1: Cut-and-Paste DNA

"It's easy to reprogram [CRISPR/Cas] to go anywhere you want," says Oliver Medvedik, director of the Maurice Kanbar Center for Biomedical Research in New York City.

Using a 20 nucleotide gRNA, the CRISPR/Cas system can easily target and lock onto a specific portion of our 3-billion-nucleotide-long genome.

Once locked on, it chops the DNA. Since cut-up DNA is about as useful as a cut-up tight rope, the body immediately works to repair the break. Human and mammal cells use two techniques for repair: non-homologous end joining (NHEJ) and homology directed repair (HDR). With CRISPR/Cas9, scientists can deliver a homology, or gene sequence, to insert into the cut site.

NHEJ is the default solution but is highly error-prone. The DNA repair systems quickly stick the DNA back together with just about any nucleotides they can find that fit. Usually this knocks out the gene by making it unreadable. In the worse case, it results in a functional mutation that is harmful to the host organism.

HDR is the preferred solution but occurs with less than 1% efficiency in human stem cells, for example, compared to 95% efficiency in unicellular yeast cells. Medvedik is working on methods to repress the NHEJ response and tweak the Cas enzyme for more efficient HDR repair.

CRISPR Trick #2: Turn Off Disease Like a Light Switch

Scientists discovered that certain variations of the Cas nuclease, in combination with inhibitor proteins, could sit and lock on to DNA, silencing a selected gene. Modified versions go the other way, and remove inhibitor proteins, turning the genes back on. The technique, referred to as CRISPR interference (CRISPRi), is 95% effective in silencing genes whereas cutting them using Cas9 resulted in only 60-70% suppression and introduced greater risk.

CRISPR and Computers: Meatspace and Cyberspace

Previous gene-editing techniques required customized proteins for each gene sequence, an expensive and error-prone process. For CRISPR, changing a 20-nucleotide gRNA sequence is "ridiculously simple" and can be done online, says Medvedik.

He caveats, though, that "meatspace is different from cyberspace." Computers have drastically lower error rates and can run experiments in seconds, while bioengineering techniques run at high error with many months between the question and answer parts of the experiment.

Up Next: Business in Genetic Engineering

Next week, we'll discuss the ongoing patent dispute deciding who profits from CRISPR use in the marketplace.

What is Compassionate Technologies?

Each Sunday we deliver to your doorstep an inspirational and educational piece describing a certain trend in technology and business.

We go from small to large throughout the year. This month focuses on Genetic Engineering, progressing up to topics in robotics, artificial intelligence, environmental and then space technologies.

Each month has four parts:

1st Sunday: Trends
2nd Sunday: Research
3rd Sunday: Technology
4th Sunday: Business

To keep our doors open, fund interviews with top scientists and industry players, and to continue hosting local events, we charge $150 per year for 52 print weeklies.

While we're getting started, I'm doing free deliveries in my neighborhood for the month of June. Please enjoy and consider joining me on this journey!

Kindly yours,

Olivia Jeffers

Thoughts?

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"If a flap of a butterfly's wing can be instrumental in generating a tornado, it can equally well be instrumental in preventing a tornado." – Lorenz, 1972