

TEXAS TRIPLE HELIX.

FALL 2019



LAB-CULTURED MEAT

WE ARE CLOSER THAN YOU THINK

P. 4-5

VOLUNTOURISM

UNTRAINED VOLUNTEERS MAY DO

MORE HARM THAN GOOD

P. 8-9



DO WE HAVE FREE WILL?

THE INCONGRUENCE
BETWEEN NEUROSCIENCE
AND CRIMINAL JUSTICE

P. 18-19



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STUDYING SMARTER WITH DESIRABLE DIFFICULTIES

NATHANIEL RALEY WOODWARD

Everyone wants learning to be quick and easy. Indeed, an entire industry has been built up around this desideratum: MCAT study guides, Shakespeare Sparknotes, Idiot’s Guide To XYZ, apps that claim that you can learn a new language in a month. Plus, students report that if a learning experience feels easy or fluent for them, then that means that better learning is taking place! For example, a recent survey of college undergraduates revealed that the most popular study strategy is “rereading notes or textbook” (Karpicke, Butler, & Roediger, 2009). Rereading and highlighting feels easy and familiar compared to more difficult-to-implement study strategies such as spacing out one’s study sessions (instead of cramming), quizzing yourself over the material (without looking at the answers), interleaving different topics (instead of binging one topic at a time), and summarizing concepts in one’s own words (instead of copying things down verbatim). “Desirable difficulties” such as these have been consistently shown to produce better learning than strategies that students perceive as easier (Yan, Clark, & Bjork, 2016). These conditions that slow learning down or make it harder often produce better long-term retention of knowledge and increase the probability that you will be able to use this knowledge in new situations (i.e., “transfer of learning”). But if you ask students to rate the effectiveness of study strategies, the ones that work best often end up at the bottom: intuitively, we really don’t know what’s good for our own learning.

Of course, there is a reason for the popularity of “magic bullet” products such as these, and of course there is a reason why students cram. These things work! But this comes with a huge caveat: they only work for short-term gains! The research is unequivocal on this point: Easy in, easy out. Study after study has shown that learning gains are easily lost with superficial study strategies. Cramming right before a test helps you on that test, but after a delay, the cramblers quickly forget while those who spaced out their study across multiple sessions can remember much more (e.g., Rawson and Kintsch, 2005). This finding—known as the “spacing effect”—is very robust: spacing out one’s studying produces superior retention relative to an equivalent amount of time spent cramming (see Cepeda et al., 2006 for a review). Another very effective strategy that is easily overlooked is “retrieval practice”—testing yourself over information often produces better learning than restudying it. Students often think of testing like stepping on a scale: a scale tells you how much you weigh, but getting on it doesn’t change your weight; a test tells you how much you know, but doesn’t improve your memory. But this analogy is false! Every time you retrieve information from your own memory, your memory for that information becomes stronger and lasts longer (for review, see Roediger & Butler, 2011)!

In general, educators devote a substantial amount of effort toward facilitating initial learning, but relatively little effort toward maintaining it! Teachers and students are often operating under the false assumption that short-term performance (e.g., on a unit test) ensures performance over longer periods of time (e.g., on the final exam, or even on the job). The broader implications are stark: it is known that a substantial portion of basic science knowledge acquired in college is forgotten by the time individuals enter medical school, to say nothing of residency or practice (e.g., Ling, Swanson, Holzman, & Bucak, 2008). However, simple educational interventions that help medical students space out their learning and engage in retrieval practice have been shown to produce not just better retention of information, but improved quality of care in a clinical setting (Dolan, Yialamas, & McMahon, 2015; Butler & Raley, 2015). As I see it, the goal of education is to help students develop durable knowledge and skills that can be flexibly applied to new situations. While these long-term outcomes are hard to measure, we must make such assessment routine and implement desirable difficulties, such as spacing and retrieval practice, in the classroom in order for students, teachers, employers, and other stakeholders to accurately judge the quality of learning that has taken place.

References can be found on page 24 of the journal.

CONTENTS

MANAGEMENT	From The Expert	2
Parker Spradley Ethan Wang Alyssa Wu	Nathaniel Woodward, PhD	
	Lab-Cultured Meat	4
	Victor Liaw	
WRITERS	Tooth Regenerative Therapy	6
Omkar Patel Rahul Pentaparthi Victor Liaw Aaron Luna Alisha Ahmed Emillyne Thomas Montavius Coleman Jina Zhou Amy Pham Sofia Ferguson	Omkar Patel	
	Voluntourism	8
	Sofia Ferguson	
	The Art [Or Science] of Pedagogy	10
	Alisha Ahmed	
	Reminiscing in Real Time	12
	Rahul Pentaparthi	
EDITORS	Sexual Assault’s Attack on the Mind	14
Isabel Draper Kevin Ye Lois Owolabi Sabrina Benitez Sarah Campbell Jennifer Liu Jessica Zhang	Emmilyne Thomas	
	Population Control	16
	Amy Pham	
	Free Will	18
	Aaron Luna	
DESIGNERS	The Development and Ethics of AI	20
Lauren Do Sophie Liu Jeik Yoon	Ethan Wang	
	Direct to Consumer Testing	22
FINANCE	Jina Zhou	
Faiza Sawar	Is That a Disease?	23
	Montavius Coleman	



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CHEMISTS IN THE KITCHEN: LAB-CULTURED MEAT

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As our global population continues to grow, so does our collective need for food, water, and land. With the amount of finite resources slowly dwindling, it becomes ever more important for scientists and lobbyists to work together to uncover the practices that hurt our Earth's longevity and hence our own. One significant practice that these experts have targeted is the practice of raising livestock. This may come as a surprise to a vast majority of meat consumers today, who only see a final product sold in abundance in supermarkets or restaurants. Perhaps only farmers and environmentalists are truly aware of the sheer cost that is needed to raise livestock. These unsustainable practices simply cannot coincide with a healthy, growing global population. However, meat is also a staple part in the diets of 80 percent of our global population, so to call for global vegetarianism right now would be absurd. Fortunately for the carnivorous tree-huggers out there, scientists have been able to produce what is called 'cultured meat' in a laboratory setting, which could make raising livestock obsolete. Although the cultured meat industry is still in its infancy, further development in this field can make sustainable meat consumption a reality.

It's important to first note how harmful the livestock industry is to our planet. Currently, livestock account for 27% of global freshwater consumption, occupy 26% of the land on Earth, and consume almost half of the world's harvest.^{2,3} Additionally, the meat industry is responsible for 15% of all greenhouse gas emissions, which, although less impactful than vehicle or factory emissions, is a significant contributor to global warming.⁴ When considering the combined effects of enteric fermentation, feed production, and manure management, livestock are the greatest source of methane emissions, which equates to over eight gigatonnes of CO₂ each year.⁵ The accumulation of greenhouse gases is further exacerbated by the destruction of forestlands the size of Portugal, which further results in the loss of biodiversity, soil degradation, and water pollution.⁶ Yet despite the high resource cost of livestock, the returns in

the form of final meat products are actually quite low. To put this into perspective, one kilogram of steak requires 25 kilograms of grain and 15,000 liters of water.⁷ Although livestock resource usage is manageable now, choosing to allocate resources for livestock versus more efficient crops or other enterprises will become more complicated. Beyond these serious sustainability concerns, there further exists an abundance of ethical problems with raising livestock. Overcrowding, indoor confinement, inability to engage in natural behaviors, neglect, and inappropriate breeding practices for sake of efficiency are just a handful of the ways that farm animals are mistreated and suffer, not to mention the slaughtering process.⁸

Reconciling resource-consuming practices such as livestock raising with our growing global population will become increasingly difficult as time goes on, but a change in diet may help to alleviate the strain on our planet. The transition won't be easy at all, since meat is such a long-standing part of the diets of many cultures. A purely vegetarian diet, though manageable, would be admittedly bland and disappointing for some of today's meat consumers. Fortunately, cultured meat can be the best of both worlds, sustaining our Earth's precious resources while keeping meat on the shelves.

Cultured meat is grown through in vivo harvesting of animal cell tissues. These cells proliferate readily and include stem cells, myoblasts, or myosatellite cells (skeletal muscle cell precursors).⁹ They are then placed in a growth medium, which provides the nutrients needed to further proliferate. Finally, these cells are grown on a scaffold to produce a three-dimensional and recognizable shape. The idea behind producing cultured meat is less than two decades old, but major developments have already been made in this new field of cellular agriculture. Early pilot studies involved cells from smaller animals, including turkey, frog, and even goldfish cells.^{10,12} Eventually, scientists moved to larger scale animals, and in 2013, professor Mark Post was the first to produce a lab-grown

burger patty, which further cemented cultured meat as a reality for future generations.¹³ But with the advent of any new technology comes healthy skepticism and doubt. The most pressing concerns are economic in nature. Even if cultured meat is better in the long-run, most people wouldn't even consider the transition so long as the alternative is cheaper. Early trial experiments were incredibly expensive; it cost 250,000 euros for Dr. Post and his team to produce a single burger patty, and Dr. Post believes they will one day be able to reduce the cost to eight euros.¹³ Other groups have made similar progress; Memphis Meats was also able to decrease costs from \$18,000 per pound of cultured beef in 2016 to \$2,400 per pound in 2017.¹⁴ Although there is still a long way to go for cellular agriculture to be mass produced and economically competitive with standard meat production, the rate of scientific progress in the past two decades has been tremendous, so it's incredibly likely that cultured meat will become affordable for all in the near future. This same affordability, however, could potentially cause severe disruptions in many global economies that rely on livestock, particularly in some developing nations, where livestock can account for up to 40% of their agricultural gross domestic product.² Recognizing and preparing for these potential upheavals will become an important undertaking for future policy-makers and economists.

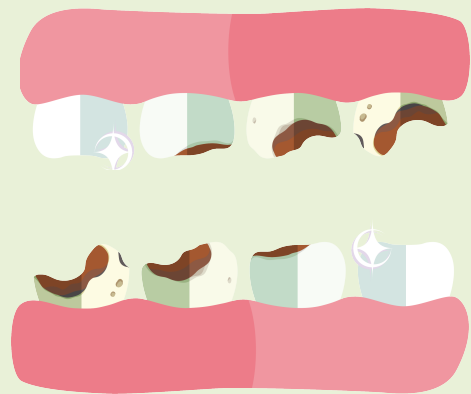
Moreover, as the technology becomes even more mainstream, scientists will have to convince the public that cultured meat is safe to consume. A 2014 survey found that only 20% of responders would be interested in consuming meat grown in a lab.¹⁵ The fact that cultured meat is currently produced in a laboratory setting is one of the major reasons why many consumers would rather eat something more 'natural'. This phenomenon of eating 'natural' is also seen in those who buy organic over regular foods. Chemical fertilizers, insecticides, chemical herbicides, and medications are used to grow and preserve regular, non-organic foods.¹⁶ Although these chemicals pose no health risk and the end product tastes almost the same, if not identical, the use of artificial, man-made materials alone is enough to convince some people to spend more on organic foods.¹⁶ Therefore, advertisers will have to figure out how to overcome this artificiality bias and combat potential misinformation that arise. Contrary to public belief, cultured meat can potentially be healthier than natural meat. Cultured meat does not necessarily require growth hormones, and its production does not require antibiotic use. Though antibiotics are highly utilized on non-organic livestock, it is incredibly unlikely that anyone will actually consume the antibiotics themselves; however, it is possible for antibiotic-resistant bacteria to be transmitted to food products.¹⁷ The studies and regulations on this topic remain dubious due to a lack of a centralized metric, but although the risk of infection is incredibly low, this risk can be completely mitigated by consuming cultured meat instead. Further, cultured meat can be additionally supplemented during production, meaning that it can potentially be more nutritious than natural meat. But given these numerous benefits, it's equally as important to be aware of the potential health costs. Any novel technology can present certain flaws or problems that may become apparent as time goes on, and regulations on the industry are untested and

potentially deficient. Further, cultured meat likely carries some of the same health risks as traditional meat and perhaps even more, though this is unlikely. Fortunately, continued research and innovation in the field can bring up some of these potential issues before they hit the market, ensuring a healthy and safe final product.

Over the next few years, the price of cultured meat will likely further decrease, and the time that it begins to appear in supermarkets will mark the beginning of the end for the natural livestock industry. Though raising livestock has been a cultural and traditional pastime for almost all global cultures, the practice is simply unsustainable for our modern era and burgeoning population. The cultured meat industry still has a ways to go to make the product mainstream, and it needs to deal with economic, cultural, and psychological barriers that stand in its way. Plus, it needs to actually taste good for people to want to buy it. But beyond these surmountable obstacles lies a realistic future where cultured meat can provide a meaningful and lasting compromise between meat lovers and our planet.

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TOOTH REGENERATIVE THERAPY: CAN WE REGROW TEETH?

AUTHOR OMKAR PATEL AND EDITOR ALYSSA WU. DESIGNED BY SOPHIE LIU.

Nobody likes to see the dentist these days. How can anyone enjoy being poked, prodded, and drilled into? Right now, fillings are the easiest way to battle tooth degradation. This procedure can be uncomfortable, time-consuming, expensive and risky. There are many debates on the safety of metals used in amalgam, the mixture that makes up fillings. Amalgam usually consists of inorganic metals such as mercury, silver, tin, and copper. Liquid mercury makes up the majority of amalgam due to its unique chemical properties, but its overall safety is questionable. While the FDA has deemed mercury fillings safe for the general public, they may have an adverse effect on the neurological development of young fetuses and infants.¹

While higher-income families can afford fillings, people of lower socioeconomic backgrounds have difficulty gaining access to even the most basic dental procedures. As a result, they are forced to view dental procedures as a luxury rather than a necessity. According to one statistic, fifty-three million Americans live with untreated decay in their permanent teeth.² This number is spread out



inconsistently among different ethnic groups living in the United States. If you look at the data, certain groups of people are consistently being ignored when it comes to the treatment of tooth decay. When looking at children aged 6-8, one study found that Mexican American children were 15% more likely to have tooth decay than non-Hispanic white children. Children of Native American descent have even more troubling figures. According to the same study, 87% of Native American children aged 6-14 have untreated tooth decay.² Clearly dental decay is a pervasive issue that affects minority groups the most. Why is decay so important to treat? While it may not be deadly, the pain caused by tooth decay has consistently been shown to decrease self-esteem, cause people to skip school and work, and find it difficult to concentrate on everyday tasks.² To make the treatment of dental decay more affordable, accessible, comfortable, and effective, we need to explore other approaches. As always, science can be the answer to our problems!

The fundamental issue with current treatment plans is that they treat teeth as though they are just dead structures that need to be fixed. It is important for us to realize that our cavities are not potholes in a broken road; our teeth are amazingly complex and very much alive. As our understanding of biological systems strengthen, it is important for dentists to seek biological solutions rather than mechanical solutions. In other words, we can use the body's natural mechanisms to treat decay. Let's regrow teeth!

Before we dive into how we can regrow teeth, we need to understand the basic anatomy of a tooth. A healthy tooth is made up of three main layers - the tough outer enamel, the tissue-filled dentin, and the blood-vessel rich inner pulp. The majority of dental regrowth care is aimed at the dentin layer and the pulp. Recently, a few researchers have been trying to regrow enamel, but the results have not been very promising.³ Fortunately, researchers have found many reliable ways to regrow the inner dentin and pulp complex. In doing so, they have figured out ways to regenerate the majority of the tooth and allow sensation to come back. They have basically found a way to bring life back to something that was once dead. Researchers aren't just fixing teeth, they're reviving them! So, how can they do this? Unlike other bones in your body, your teeth cannot just magically heal themselves when they degrade. Dental pulp originates from the mesenchyme layer of an early fetus, which forms the skeletal system and blood vessels

of humans.⁴ The main problem here is that these cells stop regenerating in adulthood. The good news is that we can bring back the function of these important cells and induce teeth to "heal themselves" by using cell transplant or cell homing.

The cell transplant method is easier to understand but harder to carry out in practice. In this method, stem cells are directly harvested from developing fetuses and transferred into decayed adult teeth to promote the growth of the dentin-pulp complex. This method comes with serious legal and ethical questions, due to the fetal source of the stem cells. While this method has proven successful with mice, it is quite obvious why this method cannot easily be used on humans.⁴ One way to bypass the ethical obstacle of harvesting cells from fetuses is to use your own stem cells to treat your own tooth decay. This idea was tested out in a long-term controlled experiment in China with 40 children who had broken their teeth.⁵ These children had their stem cells harvested when they were babies. After transplantation of their own stem cells, the treatment group developed thicker dentin, more blood vessels in the pulp, and more sensitivity after one year. Though the results of this experiment prove fruitful, the cell transplant method has too many limitations to be practical for tooth regeneration. As seen in the above study, it requires long-term foresight, as cells must be harvested early on in infancy before they stop proliferating. From a clinical standpoint, storage of stem cells is expensive, requiring cryopreservation, banking system, and special training to inject the cells. Stem cell transplant could also result in considerable risk to patients as it can cause immune rejection or the development of tumors.⁴ If an important goal of dentistry is to make dentistry more affordable, then surely cell transplantation would be counter-productive. Thankfully, a new method known as cell homing offers some ways to bypass the obstacles that cell transplantation faces.

In cell homing, a patient's own endogenous cells are stimulated by some biochemical process and migrate towards the dentin pulp complex. Here, they can divide and heal the tooth decay.

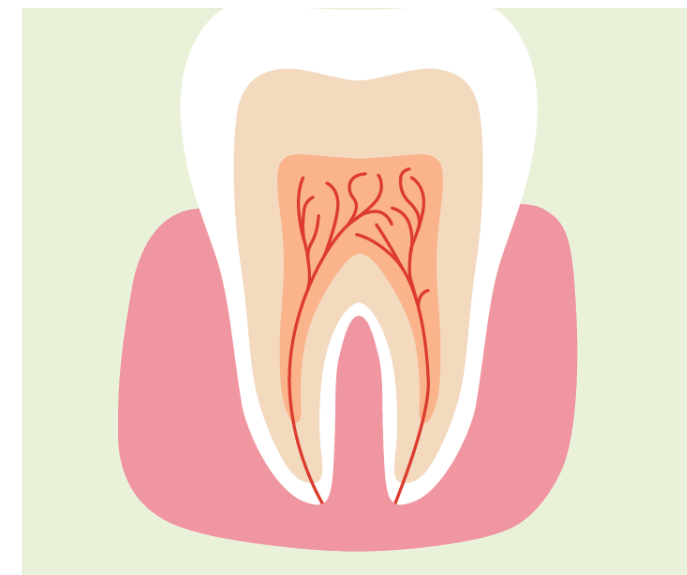
Cell homing makes use of an individual's own stem cells when they are adults and does not rely on an external source. Thus, most of the risks and expenses associated with cell transplanting can be completely avoided. Recently, it has been shown in mice that low-intensity lasers can be used to promote dentin growth. In one experiment, it was found that lasers could stimulate reactive oxygen species in the teeth that can then activate growth factor beta-1 (TGF- β 1), a protein responsible for cell differentiation and proliferation.⁶ In other words, lasers can induce a biochemical pathway that results in the regeneration of the dentin layer.

Another way to induce the biochemical process of cell homing is by using drugs. Some of the most important scientific discoveries come by accident, and interestingly enough, it has been shown that a drug that treats Alzheimer's, known as Tideglusib, can regenerate the dentin layer of teeth in a similar way. When the drug is dabbed onto a dissolvable sponge and inserted into the teeth, it can simulate a similar pathway that results in dentin regrowth in mice.⁷ As both cell homing methods have proven successful with mice, it won't be long before human trials begin.

The various methods discussed above all have their own advantages and disadvantages, so scientists need to find a way to create a treatment that minimizes the risks to the patients and follows the best course of ethics. Nonetheless, advances in biology are exciting professionals all around the world, and once the legal and ethical kinks are resolved, regenerative tooth therapy has tremendous potential to change the face of dentistry forever. While these are exciting advances, it is important that people don't ignore their oral hygiene just because their teeth are now suddenly "fixable." As dentistry is a preventive field of healthcare, it is imperative that proper oral hygiene is continued to be taught to patients. Ultimately, these innovative methods could prove to be cheaper and more effective than current treatments and can get us one step closer to making basic dental care something that everyone can have access to.

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VOLUNTOURISM

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The dawn of the 21st century brought with it a new meaning to the word “vacation” as increased international travel and the development of social media platforms ignited an unspoken competition to outfun your friends. Exotic experiences are praised as the most meaningful, and postable, ways to spend your time. Images of your loved ones #MakingADifference as they are surrounded by smiling orphans clinging to their shoulders in a hut halfway across the world have become commonplace in this age of international travel thanks to the development of a new way to vacation: voluntourism.

The rise of transnational tourism has allowed millions of presumably well intentioned travelers to cross international borders into underprivileged communities with the opportunity to provide an array of philanthropic services. This growing global fad gave rise to the voluntourism industry, which gives benevolent souls from around the world the chance to engage in an seemingly mutually beneficial agreement where, in return for sacrificing their time and money, volunteers may travel to third world countries on the mission to improve it. Vendors for these opportunities can be easily found through church missions, university organizations, or even with the click of a Google search, and the professionalism of these groups range from amateurs to professional programs like the Red Cross.¹ Despite the steady growth in the popularity of voluntour opportunities over the years, the ethicality of these programs has come under fire as recent studies question whether these seemingly charitable ventures are actually causing subliminal harm to the communities they aim to serve.²

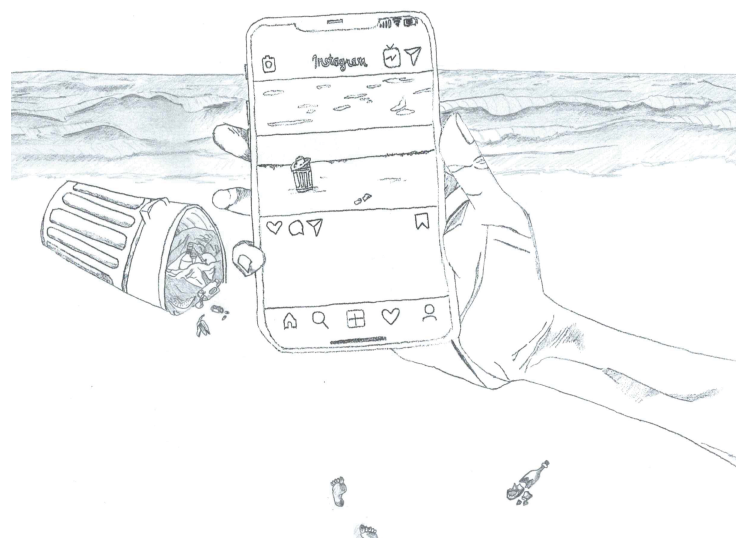
Voluntourism has been criticized for propagating systemic dependency of underprivileged communities on the humanitarian ventures that visit them.³ These opportunities impede growth of communities by displacing locals’ jobs and robbing them of the opportunity to educate themselves. Without providing sustainable initiatives that promote continuous development of host sites after the voluntour programs have left, locals are left facing the consequences of a lack of resources and education that leave them vulnerable until the next group of volunteers arrives. This constant cycle of welcoming a group of smiling strangers before seeing them replaced by an entirely new group of strangers lacks emotional depth and leaves these communities overly trusting and susceptible to malicious influences.²

For example, medical brigades are common voluntour programs that grant volunteers the opportunity to experience medicine in a foreign country while providing free healthcare to their host site. This initially appears to be an indisputably positive endeavor, for who wouldn’t want to promote wellbeing and improve a nation’s health by supplying it with proper healthcare? Areas ac-

customed to these outside influences, however, become reliant on these programs to provide them with expensive resources—medication, hygiene products, medical devices, etc.—that may otherwise be ordinarily unavailable to these communities. Impoverished countries, unable to pay for this equipment and provide its citizens with the materials they require, cannot maintain the level of treatment these programs afforded and are therefore left in the same position they were in before volunteers had even arrived.⁴ Furthermore, individuals in these sites are motivated to withhold seeking immediate medical attention in favor of waiting until another voluntour program arrives where patients can receive their treatment for a significantly lower cost. The longer patients wait to treat their afflictions, the more severe their illnesses become, and before they know it, the treatment they require may no longer work.⁴

Overzealous volunteers, as excited as they may be to impact the communities they visit, may pose some of the largest threats to the wellbeing of the areas they aspire to serve. Those who are too eager to leave tangible, and postable, marks on the sites they visit may arrive with the impression that “any care is better than no care at all,” resulting in haphazard work and deplorable finished products that would be deemed unacceptable in their wealthier home countries.¹ This is only exacerbated by the fact that volunteers who take part in these initiatives are oftentimes underqualified to provide the services they are asked to perform. This idea that these students, who are untrained in third world medicine and unacquainted with local traditions and languages, can provide truly impactful healthcare is naively optimistic.³

In the previously discussed example of medical brigades,



volunteers may participate in these programs without having obtained even the slightest of medical training. Nevertheless, they are thrust into an environment where they may be given opportunities such as writing prescriptions, suturing wounds, performing consultations, etc., opportunities that they would unlikely have been granted in their home country.¹ The popularity of these programs among undergraduate students with sights on one day obtaining a medical degree has risen as brigades market themselves as opportunities for students to receive “hands on” health-care experience.¹ However, gifting these students with the opportunity to escape the bounds of their home countries and test out medicine on the underprivileged natives they visit is unjustifiable.

One American physician gave a personal testament regarding the ethicality of these programs after taking part in an Honduran medical brigade. Volunteers were assigned the task of distributing medication to patients. When the volunteers ultimately exhausted the medicine, they approached the physician and suggested relabeling bags of vitamins and distributing these in place of the medication in the hope that patients would experience a placebo effect.³ Volunteers said they “felt compelled to give every patient some medicine since they had come from so far and waited for so long.”³ However admirable the volunteers’ desires were to serve the patients, their assumption that this treatment of natives would be acceptable is disgraceful, and the leading physician shot down their proposal for its unethicity.

Voluntourism has also been charged with fostering divisive stereotypes of a first world us and a third world them.⁵ Volunteers may enter their host sites with the mentality that they are heroes who have come to rescue the natives, and this “savior” complex has been criticized for perpetuating power imbalances and colonial legacies in these “helpless” communities.⁵ For a few days, volunteers get to play the role of rescuer before returning to their daily lives without having to face the aftermath of their actions. Pictures of tattered homes and sick children will be posted, with commenters praising volunteers for their service and sending critically needed prayers to the subjects of the photos while silently thanking God it isn’t them. Some critics argue that in the face of true disparity, individuals are more inspired to “change their profile pictures than change their perspective on health disparity and poverty” as egocentric volunteers may see these opportunities as simply a chance to show off their travels and questionable altruism.³ This mentality detracts from a valuable opportunity for volunteers to learn from the communities they visit, thus preventing them from making the most out of their trip. Voluntour programs, under the right circumstances, possess potential for aiding these communities. Care must be taken, however, to not only ensure that the services being provided are necessary and of the utmost quality, but that they center around providing sustainable effects that will last long after the volunteers have left. In-depth research on the needs and culture of the sites they hope to visit is imperative for ensuring that natives get the quality of care they need and deserve. Although it may not be as exciting as physically volunteering in these host communities, critics of voluntourism say that some of the most beneficial aid comes

from donations of material items like food, clothing and money with some critics saying money used for travel and lounging would be better spent if directly donated to these third world countries.¹ Most importantly, humanitarian initiatives should shift their focus not on simply providing aid, but on educating natives on how to use those resources and to care for their community. Implementation of such changes can push voluntourism to its fullest potential and ensure they make the impactful influences they strive for. Ultimately, human endeavors to aid others who are less fortunate are inspiring opportunities to ignite change in our world and show that, despite the suffering and hate we see on the media and around us, we still have hope for a better tomorrow.

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THE ART (OR SCIENCE) OF PEDAGOGY

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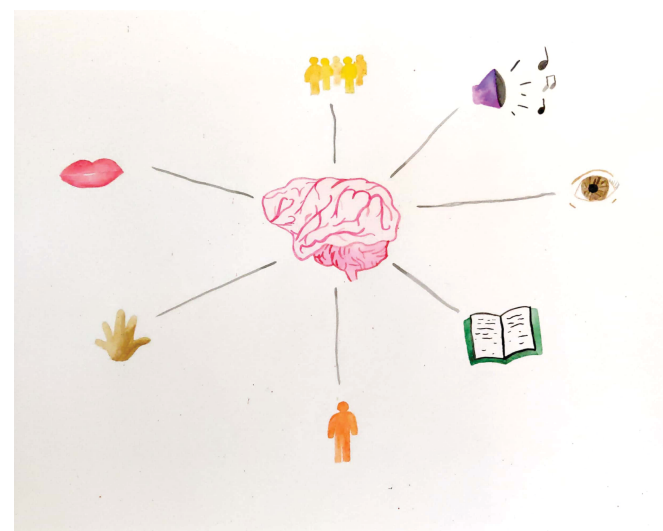
Everyone remembers that one transformative teacher. Maybe it was an eleventh grade English teacher, who changed their students through Shakespearean dialogue and extraordinary poetry. Or possibly it was a middle school Geometry teacher, who inspired her students with the Pythagorean theorem and complex proofs. Maybe it was even a preschool teacher, who molded her children and cultivated their manners by teaching them to wash their hands before sitting down for lunch. As expected, that teacher exists for everyone who has passed through any sort of educational institution. Such a mentor figure can provide so much guidance, influencing how we view the world and our interactions with others.

Education defines our community and the citizens residing in it. A slight difference in pedagogy, or the method and practice of teaching, can alter the course of a person's life or change their view on their career. As a result, it is important to understand what fosters specific interests in children, and how pedagogical methods can account for these interests at the most decisive times. Additionally, questioning our foundations for our educational institutions and methodologies becomes crucial. Education has been found to be a natural, innate aspect of humanity. "Natural pedagogy," or an innate communication system that allows humans to effectively transmit information and generic knowledge to others, has been found to exist and represent the pedagogical tendencies of our species. This characteristic of humans is innate. Infants are born with the biased sensitivity to certain signals from their parents and the ability to demonstrate certain expectations from them.¹ In other words, newborns exist with the ability to communicate to their mothers their wants, needs, and expectations through crying. Similarly, babies involuntarily learn the language of their parents through observation and constantly being surrounded by the words their parents share. As a result, humans have been shown to possess a natural sense of learning and reception.

Although learning from parental and familial figures has been an age-old aspect of humanity, teaching has evolved greatly over the course of human history. The first official "teachers" can be thought to have been classical philosophers such as Socrates and Confucius. Such figures recognized the value in educating the next generation. Western philosophers like Socra-

tes focused more on understanding if one can ever truly understand the nature of value and how one can attain it and share it with others, while Eastern philosophers such as Confucius tended to focus on what values were the most important and what must be passed down to the next generation. Such philosophers recognized the importance of cultivating the self, and employed various methods to teach these values and modes of thinking to youth. Education evolved more after the middle ages, when sons of nobility began to be sent to designated learning centers.⁴ Education was thus originally a privilege of the wealthy, white male. Public education eventually became compulsory, most likely as a result of the Protestant Revolution, in which Protestant leaders wished to spread their agendas to children. Later on, education became a way for industry leaders to train children and laborers. Eventually, women began to attend school, and schooling evolved with the changing times.

As education becomes increasingly available to more and more people, and as more knowledge is discovered that is to be taught and learned, employing more modern forms of teaching becomes crucial. Differing models and methods of teaching develop as a way to optimize the teaching process, as a way to ensure that all



students receive all necessary information and skills in the most efficient way.³ Furthermore, modern pedagogy has grown to be based on a variety of fields and approaches, including "systemic, cultural, humanistic, cyber, social, communication, and technology."³ Most importantly, organization of education into these fields allows for the most optimal form of education, that is, a form in which the least amount of materials and effort are used to achieve the maximum cognitive and educational effects. In other words, as our society grows at an unprecedented rate, our education system is forced to as well.

Certain modes of pedagogy that have recently developed include experiential learning, use of technology inside and outside of the classroom, and contextual learning. In these methods, students are encouraged to analyze the world, to find evidence, and to think critically about what they are learning.⁵ Technology such as the internet allows students access to a vast array of prior knowledge on any topic of interest. Furthermore, active learning provides students the opportunity to explore projects and topics in a tangible and realistic way.² All of these avenues of teaching involve something that greatly reflects our world, that is, its increasing socialization. Modern education is centralized on cultivating students and children as creatures of community, embracing the social nature of human beings. Some say that pedagogy is a science. Pedagogy allows for the development of multiple fields, as education creates for an organizational system for multiple fields and areas of academic interest. The goal of education additionally develops to be the most efficient and strategic way to drive critical information into the minds of humans.⁶ This leads to the question of what scientific basis both educators and societies may have for their educational system, as defining these methods becomes critical for keeping pace with our rapidly changing society, especially in a Western context.

Others say that education is an art. Teachers instill in children the ability to think, to engage with others, and to become active members of society. Education must be carefully crafted in order to allow humans to develop into the best versions of themselves that they can be. Thus, education must be individualized. Despite this need, certain questions arise. For example, how can education be standardized in an effective way if it is to remain an art? Additionally, how can we maintain the artistic nature of pedagogy if it becomes increasingly necessary to keep up with growing world populations and accumulative competition among students?

As a result, the art (or science) of pedagogy develops into an intricate topic with critical outcomes. The effects of education are ubiquitous, thus emphasizing the need for understanding the way pedagogy must evolve to fit the needs of children, as well as all those who learn.

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REMINISCING IN REAL TIME

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“Aramis.” That was the answer that closed *Slumdog Millionaire*, the 2008 Academy Award winner for Best Picture. The film, which recounts the fictional Jamal Malik’s life and romance, was memorable for its seamless integration of the plot with his progress on the game show *Who Wants to Be a Millionaire*. Touching on cinema, literature, sports, and religion, the seemingly arbitrary trivia gave way to lush episodes of his story, with each question leading into different junctures of his past. While Jamal was not actively reliving his memories as presented, such a memory is far from fictional for some.

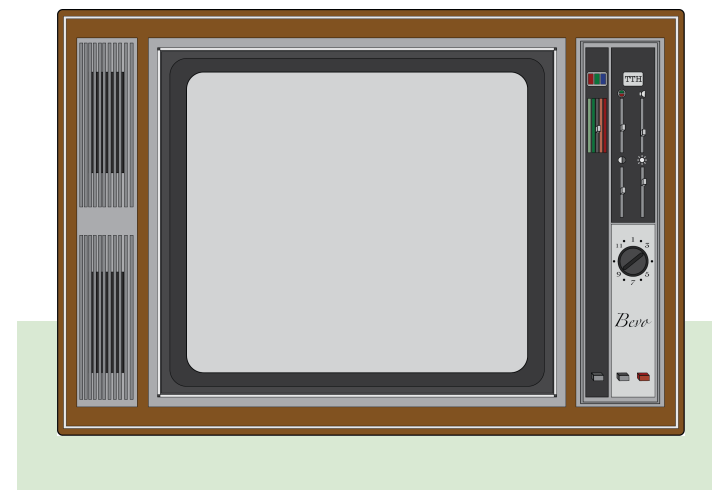
Jill Price is one such individual. In 2000, she reached out via email to Dr. James McGaugh, a professor of neurology at University of California, Irvine, whose research focused on memory. In her message, Price claimed she could “take a date between 1974 and today and tell you what day it falls on, what [she] was doing that day and if anything of great importance... occurred on that day.” She soon became the first person to be diagnosed with Highly Superior Autobiographical Memory, or HSAM. At its core, HSAM is characterized by a “selectively strong memory for... personal daily experiences,” and people with HSAM exhibit an ability to recall personal or culturally significant details from almost any day of their life after the condition’s onset. Tests for HSAM are built around this principle, screening candidates’ abilities to associate dates with significant events in their lifetimes and vice versa. For example, Price was asked about noteworthy public events after 1975, prompted with dates such as August 16th, 1977, which she correctly identified as the death of Elvis, and events such as the start of the Gulf War, which she pinpointed as January 16th, 1991. Price was also asked about details of personal significance associated with a set of dates. She was interviewed in separate sessions spaced 2 years apart, and she recalled the same details with remarkable consistency. Price’s case was a watershed moment in HSAM research, setting the stage and criteria for the identification of other HSAM individuals.

While Price is the first person to be officially diagnosed with HSAM, the first documented case is thought to be Daniel McCartney, who was interviewed in *The Journal for Speculative Philosophy* in 1871. McCartney exhibited a strong memory for local weather, personal experiences, and culturally significant events to the day as far back as 1827, and several of his answers were verifiable against limited weather records from the period. Unfortunately, his case was largely overlooked due to the obscurity of the publication, and HSAM was left unexplored until McGaugh’s work with Price. Since the first paper reporting Price’s case in 2006, only about 100 HSAM subjects have been found worldwide, suggesting they represent a miniscule subset of the population.

Even in this small sample, there have been significant findings.

Neurologically, structural and functional MRI studies have shed light on some common characteristics of HSAM. The studies found unique development patterns in areas associated with episodic memory, or memories of experience, and habit formation. A key region that appears to be involved with the condition is the amygdala, which is associated with activation by emotion. This feature suggests emotional stimulation could be important in the development of HSAM. Surprisingly, HSAM subjects may be as susceptible to misremembering as controls. In a study, participants were told about a video of a plane crash, but no such video was ever taken. 20% of HSAM participants, however, still claimed to have seen the video, compared to 28% of the control group. Consequently, the memories of HSAM individuals do not meet the cinematic quality of *Slumdog Millionaire*. Rather, their memories are akin to an uncanny knowledge of the screenplay, recalling key information about their experiences with remarkable precision but exhibiting the same limitations the rest of us do in summoning peripheral details of the moment. Researchers further found that most of the cohort reported HSAM developing when they were 9-11 years old, indicating HSAM could arise in a certain developmental window. Finally, the cohort share a predisposition towards obsessive behavior, scoring at a significantly higher average on obsessiveness tests compared to the general population. Overall, the cohort provided core findings about HSAM, but true interest lies in what the condition could contribute to our understandings of memory in general.

One circumstance that makes HSAM so interesting to researchers is its potential for studying dementia. In the United States,



our aging population is a pressing social concern. As baby boomers and subsequent generations approach seniority, dementias such as Alzheimer’s disease are projected to pose a prevalent healthcare burden. Mouse models represent a central avenue of current pre-clinical studies on Alzheimer’s. These models can help elucidate the molecular mechanisms of Alzheimer’s for pathophysiology and drug testing, and well-designed behavior assessment and cognitive studies can also convey essential information on overall cognition. However, mice are limited in their ability to model human cognition, and compared to humans, they exhibit accelerated developmental patterns. Individuals with HSAM, on the other hand, represent a more applicable, unique framework to understand cognitive pathways associated with memory. More importantly, they offer a human model to track a novel pattern of cognitive aging. Biomarker and neurological differences between HSAM individuals and the average population over a lifetime could be imperative to understanding and treating the loss of autobiographical memory. Viewing them through rose-colored glasses, however, makes it all too easy to ignore the individuals’ best interests.

For all the promise their memories offer for scientific study, HSAM individuals face unique obstacles on a day-to-day basis. Later in her same introductory email to Dr. McGaugh, Price stated “I just hope somehow you can help me... whenever I see a date flash on the television... I automatically go back... It is non-stop, uncontrollable, and totally exhausting.” Indeed, the obsessive and all-encompassing nature of the condition offers its own debilitation, detracting from HSAM individuals’ ability to live in the present. This leads McGaugh to wonder “should HSAM be considered a handicap?” in his closing remarks to his review. The stress of the condition also contributes to conditions such as depression and anxiety per Joey DeGrandis, an HSAM individual who cites personal experience and his conversations with other HSAM individuals as evidence. DeGrandis notes that the distraction of the disease ironically interferes with his short-term memory, making him forgetful of his current daily experiences. Beyond these direct symptoms, the social attitude towards HSAM carries its own burdens. Due to the rarity and nature of HSAM, the attention paid to the condition falls on a select few people, and the condition can quickly dominate their social identities. For example, a 2010 presentation of *60 Minutes* featured publicly known HSAM candidates, but Price opted not to attend, citing the media’s treatment of her condition as a “sideshow.” However, scientific interest may well outpace the media as a source of exhaustion. With the chance they represent and the need for longitudinal observation of their development, HSAM individuals could find their lives tethered to research. While most discovered individuals seem to embrace this role, others may grimace at having their lives further commandeered by a condition that already dominates their worldview. This latter group could become more prevalent if the screening process changes from a subject-driven to a researcher-driven effort. Currently, most of the identified individuals initiated the screening effort by reaching out to researchers via email or taking an online test. If the paradigm shifts, however, such that psychiatrists begin actively screening for individuals who come in for a different con-

dition such as anxiety, identified HSAM individuals could resent the unwanted attention. The early age of onset amplifies the risk of research overstepping its bounds by recruiting minors for research. Recently, McGaugh’s lab identified an 8-year-old with HSAM, and the individual’s case could provide insight into how memory changes with adolescence. Beyond the potential discoveries awaiting, the

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NOT JUST PHYSICAL: SEXUAL ASSAULT'S ATTACK ON THE MIND

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The 2017 #MeToo movement sparked a nationwide conversation focused on sexual assault. Women and men have spoken about their experiences and how it has changed their lives, often on a very public stage. In cases like *People v. Turner* in 2016 and the more recent Brett Kavanaugh hearing, American society has been forced to take a step back and evaluate how trials can affect victims of sexual assault.

Often times, victims do not act the way people think they should during an attack. School administrators, police officers, investigators, and even the victims themselves tend to question the victims' reactions (or lack thereof). Humans have a fight-or-flight response that causes us to behave in certain ways in threatening situations. A deer caught in the headlights experiences a similar reaction to a victim experiencing a sexual attack. Both induce fear and an unexpected, yet common, response: freezing.¹ People often freeze before or at the start of an attack because the amygdala, the part of the brain in charge of the perception of fear, sends signals to other parts of the brain that prevent the body from moving. This freezing creates a state that allows the victim to escape or defend, if it is able to.¹ While the victim is still frozen, the prefrontal cortex is essentially shut down by a release of dopamine and norepinephrine, among other hormones, which work together to prevent the prefrontal cortex from operating effectively. The prefrontal cortex controls an organism's ability to perform executive process, like decision-making, memory formation and higher-order cognitive functions.² Without these abilities, the brain relies on habits and reflexes. If a victim typically responds to unwanted sexual advances with passive behavior, the brain will again rely on this defense rather than the "common sense" response of running out of the room or fighting off the attacker.¹ Another common response after freezing is tonic immobility, a prolonged frozen state. Tonic immobility temporarily prevents movement or calling out—the body is frozen in fear to prevent serious injury or even death. The body can even enter another form of tonic immobility called collapsed immobility, which can cause muscles to go slack or even make the victim lose consciousness.³

The release of hormones into the prefrontal cortex during an attack promotes the victim's survival, but it can also prevent proper memory formation.⁴ Victims will often have incomplete or fragmented memories of the event because their prefrontal cortex

was not active during the attack. A victim may only clearly remember specific details because the amygdala will switch the focus of the victim's attention.⁵ A victim might remember the color of the attacker's shirt instead of the precise location and time of the attack because the time and location is not immediately threatening.⁶ On the other hand, a victim may only have a clear memory of the environment because they shifted their attention away from the sensations of the assault as a way to emotionally protect themselves.⁵ The reason for fragmentation or incomplete memories stems from the amygdala's interaction with the hippocampus. The interference of the excessive hormones present, the fear of the immediate threat and the amygdala will all negatively impact the hippocampus and its ability to properly encode experiences into memories. Over time, the human brain has evolved to prioritize the details the victim focused on or that were perceived as the most threatening to promote survival if faced with the same threat later on. This leads to the crystal clear memory of the attacker's hand around the victim's throat or other striking or emotionally charged details.⁷ These central details stay ingrained in the memory and cannot be distorted over time, even if the victim doesn't retrieve that memory for a substantial amount of time. A victim might also experience unexplained pelvic pain. Known as a body memory, these sharp pains are actually a form of flashbacks and are often not recognized as related to the event, rather thought to be a symptom of something else entirely.¹¹

The after effects of a sexual attack can linger for days, months, and even years. One of the most common emotional consequences is post-traumatic stress disorder, or PTSD. Post-traumatic stress disorder, especially in victims of sexual assault, happens after someone is placed in an environment that causes a buildup of stress hormones in the body. Cortisol, a major stress hormone, is released by the adrenal gland when it is hormonally stimulated. During an attack, the adrenal gland receives more stimulation, leading to an increase in cortisol release. This prevents key regulators from doing their job and forces them to become overactive, releasing even more cortisol into the body. This excess amount of cortisol increases stress in the body and will lead to the common symptoms seen in sufferers of post-traumatic stress disorder.⁸ Post-traumatic stress disorder can be a long term disorder, as individuals may never be able to fully recover to their original baseline of memory-related processing.² Symptoms can be sleep distur-

bances, emotional detachment or flashbacks or mental replays of the assault. Other symptoms, whether physical or psychological, besides post-traumatic stress disorder can also manifest in victims. Survivors can also experience behavior changes in a social context or in actions that put their general health and well-being at risk.⁹

The body can have an array of emotional and physical reactions to an unwanted sexual encounter. The emotional toll of a traumatic event can dramatically impact the victim's relationships, their physical health, and their mental wellbeing. In addition to dissociation during the actual event, victims can begin to use dissociation as a way to cut off emotions about an event. Although victims might appear normal and look as if they are able to cope in wake of a tragedy, they might actually be keeping themselves from feeling and preventing normal emotional interactions. What is commonly known as "emotional numbing" can damage current or prevent future relationships with other people. Without the ability to feel and process emotions, people are unable to process grief, protect themselves, or find meaning and joy in life, all of which can become a serious liability to their physical and mental health.¹¹ Another potential reaction to an assault is a loss of the ability to regulate responses to stimuli. Someone might overreact to an ordinary, everyday problem. They might also be irritable, jumpy and on-edge. They might only have two emotional states: emotionless and unable to control their emotions at all.¹¹

Various studies on the impact of a sexual assault or rape confirm its detrimental impact on mental health. Boys who were abused at a young age were 13 times more likely to attempt to commit suicide than non-abused boys.¹² Investigators also discovered 30 percent of rape victims have experienced a major depressive episode in their life and were 4 times more likely to contemplate suicide. The same study also uncovered 13 percent of rape victims actually attempted suicide.¹² Somatization, the process of emotional and psychological stress manifesting into physical symptoms, was found to be 90 times higher in women who suffer from rape-related PTSD than women who do not have PTSD.¹²

Surveys from 2010 estimate that one in three women and one in five men will experience sexual violence in their life and one in five women and one in 71 men will be raped.¹⁰ This estimates that over 33,000,000 women were raped in 2017. These statistics bring forward a reality that was long-ignored: sexual assault is still happening.



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POPULATION CONTROL

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The concept of population control, also referred to as human population planning, involves attempts to manipulate the population of a region, usually a country. In particular, some high-density countries with large populations and alarming rates of poverty are attempting to reduce their population, while other countries with a declining birth-rate, such as Japan, are struggling to maintain their population. Population control policies are regarded as controversial due to the limits they place on human autonomy, specifically women's autonomy, on the number of children they can have. In addition, the notion of freedom vs. control becomes an issue with population control, as people who oppose it say that freedom is given up for the sake of control. Still, others argue that this is necessary for the betterment of society. Moreover, it is unclear whether population control as a means is imperative for the sake of the world, or if beliefs surrounding it are misguided.

It is well known that poverty is associated with a greater number of children, who would hypothetically require more resources. Some scholars have reasoned that this is due to a lack of technological advances, because these families need extra hands for labor.¹ Nevertheless, though other scholars do not specifically name technology as a factor of why families in poverty tend to be larger, it is generally agreed upon that they are so at least in part because of domestic labor demands.

Notably, China's famous one-child policy, introduced in 1979, has undergone wide criticism. Regardless, it has been found that having an additional child decreases progress in school, resulting in lower grades. Assessing the health of all the children in the family also supports the notion that reductions in family size are beneficial by freeing up resources for investments in human capital.² Furthermore, this finding follows Becker and Lewis's sociological model, which suggests that decreases in the quantity of children results in the availability of more resources to each child, meaning that the average quality of children will increase. However, though there are trade-offs in China between the quantity of children and child quality-of-living, it has been found that the one-child policy's effects on increasing human capital were modest, suggesting that its goals of improving the welfare of Chinese citizens are not yet satisfactory.

An important consequence of the one-child policy led to its abolishment in 2016, and families were officially allowed two

children afterward. When faced with the one-child policy, Chinese parents heavily favored having male children, believing they would lead to more financial security.³ Over the course of several decades of long-term effects of selective abortion, China developed a prominent sex imbalance, with men outnumbering women by 33 million overall.³ China's sex imbalance has been called the most serious in the world.³ As a result, millions of men have struggled to find wives, increasing the market demand for brides' marriage dowries, and ironically leading elders to wish they had raised daughters instead. The enactment of the one-child policy to counteract population increases failed to anticipate this disastrous consequence, serving as a warning to other population control policies to consider as many sociological, cultural, and economic factors as possible.

Other researchers have opposed population control policies by criticizing the ineffectiveness of them and the limits they place on women's autonomy. For example, in "Reproductive Rights and Wrongs," Betsy Hartmann, an environmentalist author, argues that population control interventions, such as projects that aim to generate income for families, are unlikely to produce enough economic change to the point where families will desire fewer children.⁴ Furthermore, Hartmann believes that current population control policies infringe upon women's reproductive rights, limiting choices regarding how many children they can have. Hartmann also states that countries, such as Cuba, Taiwan, and Korea, have reduced birth rates dramatically in the absence of population control policies, essentially due to the increased involvement of women in society, education, improved health care, and land reform. However, it is unclear whether women choose to have less children in these cases. The discrimination and difficulties related with being a woman in the workforce are likely to instead discourage women from having children, which means that women do not necessarily choose to have fewer children in the way that Hartmann maintains.

This raises an important consideration, one of freedom and control. The politicization of family planning opposes the notion that freedom and control should be prioritized, or at least considered. However, Jack Parsons, a sociologist, argues that population problems are solvable through politics. Parsons maintains that political systems are responsible for changing our contributions to the population control problem. Additionally, Parsons describes current attitudes towards freedom and control as dysfunctional.

Parsons conveys that an efficient society must partially relinquish freedom and control to the government for the overall benefit of the society.⁵

On a macroscopic level, it is questionable whether population control encompassing the entire world's population is necessary. Some suggest that fears about overpopulation are unfounded theories bordering on propaganda, as evidenced by Paul Erlich's questionable book, "The Population Bomb," which stirred alarmed readers by stating that population control is not only mandatory, but urgent.⁶ Though people need more resources to live other than just food, food is often the focus when hypothesizing whether populations will be sustainable in the near or distant future. Currently, more than enough food is produced to feed the global population (approximately 20% more), though in 2016, about 11% of the global population experienced world hunger due to poverty.⁷ While those in poverty must have more children for the sake of labor, they are caught in a bind by the need to provide food for them.

It is also known that the world is not lacking food, but that food is simply being wasted and is not distributed to those in poverty.⁸ Therefore, some propose that the problem of world hunger is one that government systems such as capitalism have caused. This directly relates to Parson's view that political systems have the capability of solving problems related to population control and sustainability. However, how this should be done remains unknown.

Though it is debated whether overpopulation is a problem or a myth, the future could change this indecision. Hypothetically, it is possible for the world to actually be at risk of being unable to produce enough food for the world population. Though current research points to food waste being the chief obstacle, this cannot be circumvented without crucially changing current political systems. This is not meant to be an easy task, but exists as a consideration while other options are continuously contemplated.

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FREE WILL

AUTHOR AARON LUNA AND EDITOR JESSICA ZHANG.

The American Dream, that anyone can accomplish anything through hard work, represents the core of American values. As Americans, we internalize that our lives are what we make of them and that we have free will over our choices. We believe in the idea of “good” and “evil”, because we attribute free will to people’s actions. But, biologically, is the notion of free will valid?

Although we commonly acknowledge constraints that limit our physiological capabilities, we give notoriously unfounded exceptions for our brains. We understand the absurdity of arm wrestling without hands or running a marathon without legs. Yet there remains skepticism on the biological basis of psychological problems. People afflicted with mood disorders such as depression are met with critics questioning the validity of their mental illness. This misunderstanding is founded upon misconceptions about the brain. One take on human consciousness is its basis in the supernatural, which Descartes asserts as an immaterial component that controls consciousness.¹ Under this premise, physical laws constrain the body but not the “spirit.” Descartes’ mind-body dualism aligns well with the concept of free will, because it states individuals have the final choice in their mental states. But we know the brain can be physically mapped to neurons, to which the fundamental laws of physics still apply. Like how a block cannot accelerate unless a force acts upon it, a neuron cannot fire unless enough charge enters the cell.

The validity of the supernatural notion of consciousness wanes as neurobiology advances the understanding of how the brain influences mood and behavior. The Monoamine Hypothesis states that depression is linked to insufficient amounts of serotonin, dopamine, and norepinephrine, implicating the role hormones play in mood.² Rather than a choice of consciousness, the study suggests that depression is a result of hormonal imbalance. Here, Descartes’ mind-body dualism falls short. If the mind is immaterial, mood and behavior should not depend on a mixture of hormones. Experiments like these teach us the roles that hormones, neurons, and genes play in human behavior. Further advances will continue to demystify the supernatural notion of the mind, ultimately replacing it with a materialist view.

The Libet experiment was one of the first studies to contest free will. Benjamin Libet used an electroencephalogram (EEG), a device that monitors electrical brain activity, on partic-

ipants as they performed motor activities like pushing a button or raising their hand. Participants were instructed to report the time they developed the urge to act. Results showed brain activity existing up to half a second prior to the participants’ awareness of their decision, which was coined the “readiness potential.”³ The readiness potential exemplifies that brain states prior to our conscious awareness govern our decision-making. These principles present a profound question for society whose implications could drastically change our approach to criminal justice: if identity, personality, and thought processes are completely biologically grounded, what is the extent of free will?

Most UT students are familiar with the notorious Charles Whitman—also known as the “Texas Tower Sniper”—who, among his gruesome series of murders, slayed his mother and wife in their homes before trekking to the UT Tower with several firearms. Once in the tower, he killed three people and fired randomly from the 28th floor observation deck, wounding 31 people and killing 11.⁴ The severity of the horrors he committed is unequivocal and, as many would agree, unforgivable. But it is interesting to ponder to what extent Whitman’s “decisions” were really his own. Whitman led a relatively normal life before suddenly committing to serial murder, suggesting a drastic neural change occurred within him. Prior to his shooting, he typed a suicide note which read:

I do not quite understand what it is that compels me to type this letter. Perhaps it is to leave some vague reason for the actions I have recently performed. I do not really understand myself these days. I am supposed to be an average reasonable and intelligent young man. However, lately (I cannot recall when it started) I have been a victim of many unusual and irrational thoughts. These thoughts constantly recur, and it requires a tremendous mental effort to concentrate on useful and progressive tasks.⁵

Whitman was shot and killed 96 minutes into the tower shooting. An autopsy later revealed a pecan-sized brain tumor in his amygdala—the brain center for emotional regulation.^{6,7} The case of Charles Whitman exemplifies the causal repercussions of a changing neuroanatomy on behavior. It is easy to say that if you were Whitman, you would have simply resisted such psychopathic urges. But as Sam Harris, philosopher and neuroscientist, explains,

if you had traded places with Whitman—atom for atom—you would be Charles Whitman, and by extension, commit the same deeds.⁸ Whitman did not choose to have a personality-altering brain tumor, nor did he choose the mind of a psychopath. We have the same amount of control over our neuroanatomy as we do with the hormones that regulate our mood and behavior.

These findings show the incongruence between neuroscience and the US justice system. Criminal justice relies on free will as it gives the power to blame; should an individual commit a crime, he is held morally culpable because he had the free will to do otherwise. As neuroscience advances, however, leaders will eventually have to reframe the philosophy of the justice system to become congruent with our understanding of human behavior. The main functions of the justice system are deterrence, rehabilitation, and retribution. To properly reframe our philosophy of justice, we must first consider how we weight each function. To accomplish this paradigm shift, we must reassess the goal of criminal justice. If it is to punish wrongdoing, we should focus on retribution. But if choices are deterministic, then moral culpability for wrongdoings is absolved. Thus, punishment for the sake of retribution is illogical.

If the philosophy of criminal justice is to uphold a properly functioning society, it is reasonable to imprison people who pose a danger to society, especially if we have no treatment. Say a psychopath is on trial and pleads guilty for murder. Assuming his psyche remains psychopathic, it would be beneficial to imprison the psychopath to maintain the proper function of society. But what if the “person” inside that physical body changes? Say years down the line we successfully engineer and administer an antipsychotic drug that “fixes” psychotic neuroanatomy and makes the psychopath, for all intents and purposes, a brand-new person. Under the current justice system’s philosophy, his sentence remains despite successful neurological rehabilitation. He remains punished for sharing the same physical body as its previous entity.

If there is treatment, then rehabilitation should be prioritized so that the individual can participate in society. Of the three, only deterrence and rehabilitation are plausible, whereas the illusion of free will renders retribution obsolete. Moral labels like “good” and “evil” should have no meaning in the courtroom, just as a car with faulty brakes is not deemed evil. If morality dissolves under the illusion of free will, then retributive justice loses its purpose. Thus, a rehabilitative approach would be the most ideal alternative to criminal justice.

If rehabilitation proves impractical from constraints in medical technology, punishment acts as the final alternative. B.F. Skinner, psychologist and behaviorist, popularized operant conditioning as a way to influence behavior. He states that our interactions with the environment create feedback that regulate our behavior.⁹ In this model, punishment serves to decrease the rate of undesired behavior. Applications of this concept already exist in today’s legal system in fines and jail time to discourage illegal activity. Nevertheless, if the goal of criminal justice to guide someone towards a desired behavior, there would be no reason to punish the former psychopath any further. In fact, we can argue that punish-

ing someone is only justifiable if it is the same person that committed the crime.

Changing a whole system’s approach, especially without fully accepted supporting science, is a gargantuan but nevertheless crucial task as we develop a more expansive understanding of the human brain and its role in decision making and behavior. From these studies, we are led to believe that our decisions are in fact a process of neuronal circuits, free from randomness. With this information, we should reconsider our notions of free will. It may very well be an illusion.

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THE DEVELOPMENT AND ETHICS OF AI

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Saudi Arabia's decision to grant Sophia, an artificial intelligence robot, national citizenship in October 2017 is perhaps the most prominent symbol of the inevitable progression of AI. Though many criticize Sophia's citizenship as a publicity grab, the prevalence of AI in our daily lives will only increase in the coming decades.¹ Google's Duplex, an AI voice technology created in May 2018, is another example of a potentially revolutionary artificial intelligence entity. Duplex speaks eerily similar to humans and is capable of passing the Turing test (i.e. fooling people into believing that it is a human). Still, both Sophia and Duplex are faced with significant limitations.² Sophia is limited in the variety of her responses and skilled only in conversation and facial recognition. Moreover, Duplex's human-like capabilities are limited only to the realm of appointment making.^{1, 2}

Even so, current applications of AI have already created ethical dilemmas. For example, machine learning algorithms are already used by employers in talent identification and recruiting. The Canadian startup Ideal relies on "talent acquisition software" to screen resumes and identify potential candidates through third-party sites (e.g. Indeed). Ideal has proven to be empirically beneficial to companies seeking to hire new employees. For instance, Indigo, Canada's largest book, toy, and music retailer, was able to reduce hiring costs by 71%, triple their number of qualified candidates, and improve recruiter efficiency by 3.7% through using Ideal's AI. Moreover, Ideal, theoretically unbound by the inherent biases and inefficiencies of human labor, claims to negate hiring bias.⁴ Oxford philosopher Nick Bostrom posits otherwise. Bostrom describes a scenario in which a banking firm relies on machine learning algorithms to approve mortgage applications. In this scenario, a rejected applicant sues the banking firm on the basis of racial discrimination and brings forth statistical evidence supporting his claim. While one would expect discrimination by machine learning algorithms to be impossible given that the algorithms are blind to applicant identity, the exact mechanisms of machine learning algorithms are often unknown and may detect other characteristics associated with factors such as race.⁵ Additionally, modern machine learning algorithms must be trained on existing data, which may be biased as well. Despite its numerous applications, current AI is limited in that it requires large training datasets, is unable to logically analyze causation, and fails to account for outlier events. Although machine learning algorithms may appear to "think" rationally, such thinking is never self-directed. For example, a machine learning algorithm designed to detect stop-signs in a self-driving car does

not "think" about the appearance of the stop sign like a human does. Instead, it merely recognizes stop signs due to their similarity to the hundreds of thousands of other stop signs the computer program has seen before. The stop-sign detection algorithm, untrained on other visual cues, would be incapable of identifying other road objects such as cars or traffic cones. In addition, the stop-sign detection algorithm must be trained on hundreds of thousands of images to maximize classification accuracy unlike a human, who could learn what a stop sign looks like after seeing it once. Sentient AI, capable of detecting outliers and applying human-like logic, would greatly improve computer vision algorithms similar to the aforementioned stop-sign classification algorithm. The potential human-like intelligence and incredible computational power of future AI could identify economic trends and help treat diseases, revolutionizing the fields of finance and healthcare.⁶

The existence of sentient AI is closer than we may believe. Ray Kurzweil, Google's Director of Engineering, predicts that by 2029, AI will reach a human-like level of intelligence and pass a Turing test in all aspects. Kurzweil also believes that by 2045, we will have achieved technological "Singularity" during which we will "multiply our effective intelligence a billion fold by merging with the intelligence we have created."⁷ Though bold, Kurzweil's technological prediction may not be as arbitrary as it seems, as Kurzweil has a track record of numerous successful predictions dating back 40 years. In 1990, Kurzweil predicted that AI would surpass the world's best human chess players by 2000, and in May 1997, Deep Blue's successfully defeated World Chess Champion Garry Kasparov. A litany of Kurzweil's other predictions ranging from the rise of portable computers to facial recognition to electronic memory have proven to be correct.⁸ Significant research contributions from groups such as The Blue Brain Project, which aims to digitally reconstruct the human brain, inch us closer to Kurzweil's reality.⁹

The sentience of AI could be very dangerous. Given that sentient AI may become functionally equivalent to or beyond human intelligence, the exact mechanisms of its thought may be unknown, and its actions may be unpredictable. In addition, sentient AI, unlike simple image-classification algorithms, would not be limited to one purpose. The combination of independent thought and computational power far beyond the abilities of the human brain may produce a race of AI beyond human intelligence. For instance, while biological neurons operate at around 200 Hz, modern microprocessors can already operate at a speed of 2,000,000 Hz. The possibility of seamlessly networking with other AI furthers AI's advantage over us.¹⁰ Stephen Hawking argued that sentient AI

would be capable of turning against us, and that a battle for survival against sentient AI would be unlikely to turn in our favor.¹¹ To counteract this risk, Bostrom proposes four limits to ensure the safety of AI. First, the algorithm determining AI should be comprehensible. Second, AI actions should be predictable. Criteria 1 and 2 ensure that experts can control the AI given failure. Third, AI should be impervious to manipulation, (e.g. a bomb should not be concealable from bomb-detection AI), and fourth, the responsibilities of AI should be clearly determined.⁵ Sentience of AI violates nearly all 4 of Bostrom's requirements. Beyond direct conflict, another worry of sentient AI is that it would take away jobs from humans. Automation has already stolen the jobs of manual factory laborers, bank tellers, and proofreaders. And while high-level jobs requiring expertise are generally regarded as "safe" from AI, sentient AI challenges that assumption. Computer programs have already proven to exceed doctors in their ability to read medical images, and tasks in other highly-regarded fields such as business and law may be co-opted by as AI intelligence continues to improve.^{12, 13}

Finally, the rights of sentient AI come into question as artificial intelligence becomes increasingly human. Philosopher H. J. McCloskey details the relationship between individual agency and the necessity of rights provisions, arguing that an individual must be able to claim a right for itself in its own interests to deserve that right. Given that an individual's rights entail the obligation of society to not infringe on that right, a logical basis for that obligation (i.e. an individual consciously desiring a certain right) is needed. Conceiving of such a desire requires both sentience, the capacity for physical qualia, and sapience, the quality of self-awareness associated with higher intelligence.¹⁴ A needed caveat for this conception of human rights is that the ability to claim one's own right does not have to be continuous. Those who are in a non-aware condition (e.g. coma, sleep, etc.) deserve rights given that they would be capable of claiming their agency in a more aware state. Sentient AI equivalent or beyond humans would undoubtedly exhibit the capacity to claim individual agency, thus necessitating the provision of "human" rights under McCloskey's paradigm. Another conception of human rights stems from Thomas Hobbes, who first proposed that human rights stem from a social contract in which free individuals sacrifice individual freedoms for collective safety under institutions of government. If sentient AI consciously and independently decide to participate in society as a law-abiding, contributory citizens, such a conception of rights may function as a further justification for sentient AI rights. Our relationship with AI could fundamentally change if AI is granted legal to humans. For instance, first consider how Chinese researcher He Jiankui's claims of editing the human germline to induce HIV resistance precipitated an ethical outcry.¹⁵ In a world with AI legally equivalent to humans, computer scientists could get in trouble for similar interference with AI. Legal equivalence brings about issues of AI personhood and consent, and the accepted position of humans at the top of society may be challenged.

The limited ability of AI today yields few, yet compelling ethical considerations. As AI becomes increasingly powerful, independent, and less predictable, ethical questions re-

garding AI will become far more difficult to answer. The moral status and legal protections afforded to AI will likely become contentious political issues, and the possibility of superhuman intelligence may yield a plethora of newfound ethical issues.

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DIRECT TO CONSUMER GENETIC TESTING

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Gone are the days of receiving Beanie Babies and the newest video game as birthday or Christmas gifts. Instead, new technology has made gifts such as smart watches, smart-home accessories, and now, genetic testing kits, norm rather than novelty. Genetic testing kits such as 23andMe, AncestryDNA, and Helix take a tiny sample of saliva and return a comprehensive genetic report detailing ancestry and health-related information, making access to personal genetic information easier than ever. When direct-to-consumer (DTC) kits like these first became popularized, most consumers were casual and primarily interested in non-medical components of their ancestry, such as what percentage Greek they are, or whether or not they have ancestral ties to Ireland. Part of these tests' appeal was also their ability to uncover genetic bases for novelty traits, such as having wet or dry earwax or a propensity for sneezing when exposed to bright light, and so on.

However, having access to an entire human genome, decoded, could be have much more useful applications than simply revealing whether or not a person can detect the smell of digested asparagus in their pee. The presence or absence of variants in certain genetic regions can be incredibly useful for detecting risks for certain conditions like cancers, drug sensitivities, and other diseases. Naturally, it was not long before people became interested in using genetic testing kits for these purposes. An interview with 23andMe founders Linda Avey and Anne Wojcicki, conducted back in 2007 prior to their initial product's release, reveals their original intent to inform consumers about their genetic makeup and what it could potentially tell them about diseases and conditions associated with their genes to help them make better informed decisions about their health.¹

It was no surprise, then, when 23andMe began to shift toward marketing itself as a diagnostic medical tool that could uncover genetic predispositions for certain conditions. In 2013, however, the FDA slammed 23andMe with a warning letter² accusing the company of marketing their product in a way that was “intended for use in the diagnosis of disease or other conditions or in the cure, mitigation, treatment, or prevention of disease,” without securing appropriate “premarket approval or de novo classification” similar medical devices would require. The letter further justifies premarket testing and approval of the kits, citing “potential health consequences that could result from false positive or false negative assessments for high-risk indications such as those for [BRCA-related genetic risk and drug responses].”² The agency was rightfully concerned; if, for example, a test reported a false positive for breast cancer, a patient could inadvertently subject themselves to extremely damaging and potentially morbidity-inducing treatments such as “prophylactic surgery, chemoprevention, [and] intensive screening.”² On the other hand, a false negative result would give the patient a false sense of security, allowing serious or potentially fatal conditions to go undetected until it is possibly too late for intervention. Additionally, false positive or negative test results could carry the economic repercussions of large medical bills that result

from undergoing unnecessary treatment. While diagnoses of conditions as serious as cancer would probably not be decided by a single genetic testing kit, similar repercussions can apply for less serious diagnoses. If a patient were to receive genetic testing results about their sensitivity to a drug, for example, self-alteration of their dosage solely based on these results, without consulting a health-care professional, could lead to serious medical repercussions.

By 2017, 23andMe finally completed the necessary adjustments for the FDA to finally allow them to market and sell DTC tests providing information on a patient's genetic predisposition for 10 diseases and conditions, including Parkinson's disease, late-onset Alzheimer's disease, and celiac disease.³ However, the FDA also specified that “it is important that people understand that genetic risk is just one piece of the bigger puzzle, it does not mean they will or won't ultimately develop a disease.”

Even given the FDA's approval and the presumed high accuracy that 23andMe's kits have in detecting genetic variants linked to the 10 diseases and conditions, there still could be another issue with 23andMe and similar DTC genetic testing kits. When consumers purchase the kits, it's not just their money that they are handing over. Patrick Chung, a 23andMe board member, explains that “the long game here is not to make money selling kits, although the kits are essential to get the base level data.”⁴ Instead, the company aims to become “the Google of personalized health care,” building up a massive database of genetic information extracted from the results of its kit-buying customers. The company's main goal seems to be in harnessing this data toward medical and pharmaceutical research.⁴ In July 2018, GlaxoSmithKline (GSK) purchased a \$300 million stake in 23andMe, establishing a collaboration that will allow them to utilize 23andMe's genetic database to develop new drugs.⁵ This collaboration, while potentially beneficial for medical and pharmaceutical research, raises an often overlooked issue that has underlaid genetic testing kits from the very beginning—privacy. Even if 23andMe customers are given the option to opt out of having their data used in research, the fact that the company still has access to their genetic data is disturbing. It could be used in ways that, unlike medical research, are not beneficial to society in the long run, such as for running targeted ads. A further limitation to using 23andMe data in research would be that it does not represent the current population; it would be skewed toward those who could afford a \$99 recreational genetic test.

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IS THAT A DISEASE?

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What constitutes a “disease” has always been a controversial matter. All attempts to define a disease vary vastly from one another depending on the philosophical basis of the definition. However, all definitions of disease involve a disease being an impairment to the normal functionality deemed desirable for a specified reference class by societal standards. In addition, its symptoms must be replicable throughout space and time, and the disease must have similar mechanistic onsets between affected individuals.^{1,2,4,7} Although something may be considered a disease in technical terminology, that does not mean it necessarily warrants treatment. When Boorse says “[i]f diseases are deviations from the species' biological design, their recognition is a matter of natural science, not evaluative decision”⁴, the word “disease” is value-laden and interpreted as something that is undesirable and must be eradicated. However, when concerned with the above stipulations, a disease is not always undesirable. Rather, it is the functionality of the organ or organ system that is desirable.

Throughout history, many social “abnormalities” have been labeled as diseases, including hyperactivity, female hysteria, homosexuality, and drapetomania. However, as the societal views on some of these characteristics changed over time, they were no longer considered diseases. This violates the stipulation that a disease must be replicable over time. So, why were these common behaviors considered to be diseases?

Medicalization of social issues has become problematic in that what we as a society view as a disease may be the result of our social desires rather than of the malady of an individual. Take hyperactive behaviors like attention deficit hyperactivity disorder (ADHD) for example. In 2016, over 6 million children were diagnosed with ADHD, but only ten years prior, less than half that amount of children were diagnosed.³ Is it possible that this drastic increase of children with ADHD resulted from societal views and beliefs on how children should behave in social settings? Could we be calling children diseased just because they get bored in class?

Another example of society misdefining a disease is female hysteria. The word hysteria comes from the Greek word *husterikós*, which translates to “suffering in the womb”.⁶ Female hysteria is a condition attributed exclusively to women with an abnormal sex drive accompanied by frequent changes in mood. From this definition and its gender specificity, we can see how this condition's classification as a “disease” is problematic. Some symptoms of hysteria include faintness, fatigue, dizziness, and a decreased or increased appetite, for both food and sex.⁸ However, many of these can be attributed to numerous other diseases. Because of the lack of unique symptoms, countless women in America were diagnosed with hysteria during the twentieth century. Interestingly enough, the majority of hysteric women were either unmarried, celibate, or widowed; very rarely did a married woman get diagnosed, and consequently female hysteria was a farcical medical diagnosis that was used to coerce women into sex or marriage.

Throughout history, homosexuality has been seen as

deviant and morally wrong, and thus has been classified as a disease. From a definition-based argument, a select few view this classification as valid because having same-sex relations does impair the normal functionality of the human reproductive system—it disables a couple from conceiving a child on their own. But, in the common use of the word, claiming that an individual is diseased simply because they love someone of the same sex is unjustifiable. Many scholars have tried to find genetic or biochemical explanations as to what might cause an individual to be homosexual^{5,11}, but no research has provided sufficient evidence for any linkage to science. A plethora of “treatments” such as abstinence, conversion therapy, and even shock therapy have been and continue to be used in order to rid a person of their “disease”.

In addition to homosexuality, drapetomania is another disease of the past that targeted specific individuals. “Drapetomania” comes from the greek words *drapētēs*, meaning “runaway slave”, and *manía*, meaning madness. Drapetomania was originally hypothesized by a white, American physician—Samuel A. Cartwright—and was officially defined as “the disease that made negroes run away”. This became a medicalized diagnosis, essentially deeming black people mentally ill for defying their masters and wanting their own freedom. “Symptoms” of drapetomania included sulky and dissatisfied behavior, and while unheard of by physicians, drapetomania found false legitimacy among planters and overseers.¹⁰ In the words of Cartwright, the only known cure was “whipping the devil out of ‘em”.⁶ As you can imagine, this disease and its “treatments” caught on like wildfire and was permissible due the fact that in the eyes of the slave masters, they were genuinely helping “cure” these people. But in all reality, drapetomania was racism hiding behind a medical diagnosis.

Several “diseases” of the past have been proven to be scientifically illegitimate and instead result purely from societal values. Using medical authority to diagnose people who we feel are different from us is a grotesque and blatant abuse of power. This country that we live in thrives off diversity, but if we continue to say there is something inherently wrong about being different, then where does that leave us? We must take a step back, learn from our past, and ensure that what physicians are diagnosing their patients with truly are diseases.

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