



SRO: Student Showcase

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About the SRO: Student Showcase

The *SRO: Student Showcase* presents research papers and literature reviews as well as graphic representations, data analysis, and abstracts. This issue of the *SRO* also collects some of the finest finalist papers submitted to our platform.

It is hoped that by presenting this special issue the scholarship on display will reach a wider specialist and non-specialist audience and generate feedback and a scholarly profile for the authors. Every paper in this collection has gone through a rigorous internal review process.

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Reactions to Skepticism

By Charles de Belloy

AUTHOR BIO

Charlie de Belloy is a student at the Lycée Français de San Francisco, a French high school in San Francisco. He is interested in philosophy and has participated in the International Philosophy Olympiad on behalf of the United States. As a Franco-American, he has seen the importance of having several viewpoints when making decisions or even when questioning one's beliefs. In the future, he would like to study math or philosophy. More specifically, he is interested in the impact of different philosophical perspectives as the basis of societal principals. He is also the co-Chair of the Philosophy Learning and Teaching Organization's (PLATO) Student Advisory Council, helping get philosophy education in primary, middle and high schools across the U.S.

ABSTRACT

In modern continental philosophy, nihilism has taken place as an important train of thought, both as a consequence of Christian European society and as a novel skeptic argument. It calls for the total removal of current society because humanity has now metaphorically taken the place of God and thus should create its own values and structure. The replacement of God can be attributed to skepticism, which refutes the possibility of certain knowledge. This paper compares two opposite reactions to skepticism: nihilism and pragmatic skepticism. It explores the societal and individual implications of the fulfillment of both views, contrasting the potential danger of radical change with that of conformity. The modern trend of perfectionism and how it influences these philosophies is also explored. Inalienable rights are discussed and their legitimacy or implementation is put into question. Hedonistic consequences and their effect on rational thought are also mentioned to analyze the potential shortcomings of any skeptical view. The structure of society, values, and their evolution raises questions about their validity, origins, and use.

Keywords: Skepticism, nihilism, pragmatism, hedonism, Deleuze, Vattimo, values, society, knowledge.

INTRODUCTION

For the past century, advances in science and philosophy have made skepticism a more accepted philosophical theory. Although arguments for skepticism follow the same basic arguments and logical conclusion (refuting the reliability of where we get knowledge from), the reaction to this conclusion (especially on the scale of society and ethics) can differ wildly. The idea that some knowledge is impossible has large implications on ideas we hold as absolute truths, so what people do with this change can become quite radical. The extreme case is active nihilism, which calls for the destruction of our current baseless society (and everything that's part of it), to rebuild another, better, world. Another reaction to skepticism, and the opposite of skepticism, is pragmatic skepticism, which does only what is practical with skepticism, and separates acknowledgement of skepticism from actions in society. Nihilism is inefficient because it doesn't seem to be the most efficient way to achieve its own goals of freedom and avoiding baseless claims, negative because it proposes destruction before creation, and, in certain aspects, contradictory form of skepticism, especially because it eliminates the possibility of a skeptical thought process being used in tandem with a pragmatic lifestyle and social interaction. Pragmatic skepticism avoids this destructive rejection of knowledge by acting (or, in some cases, avoiding action) in such a way as to avoid the possibility of being worse off in the long term. In this essay, skepticism is the idea that we have no way of being sure about the validity and truthfulness of our values, societal structure, and way of thinking.

Reactions to Skepticism

In this essay, nihilism is a form of extreme skepticism, as well as radical belief in a better world, that calls for the removal of many

baseless claims in society and ethics, and for the pursuit of a world that avoids the supposed mistakes of our current one. A well thought out active nihilist view is that proposed by French philosopher Deleuze. The nihilism he describes is an argument that all of society's values and ideas are constructs, seeing as they aren't grounded in any knowledge. The problem here is that these "values superior to life are inseparable from their effect: the depreciation of life, the negation of this world." (Deleuze, 1983, p.147) We have no way to know for sure what is good or bad, what society should look like, etc. because none of it is provable, so why should they rule our life? This is why to Deleuze, nihilism is a joyful practice. Furthermore, we should try to achieve perfect freedom, where, as individuals, we are no longer subject to anything but ourselves (like society, impulses, values, etc.). This perfect freedom (or emancipation as Vattimo would call it) is important because it liberates the self, and is the only value that is grounded in our reality. It doesn't rely on some larger morals, so it should be used as a base for the rest of our values and society. Achieving perfect freedom requires us to create a new society and new values that aren't baseless. To do so, we must first completely destroy the old society to not be influenced by it. This not only means getting rid of values and our societal structure, but also the impulses and even what we think as rational thinking that has led to these values and societies. He calls this negative affirmation, where we destroy to affirm this better nihilist society. The importance of the negative affirmation is that the destruction is positive, because it empowers us to release ourselves from all our restraints. He describes it as "to affirm is not to take responsibility for, to take on the burden of what is, but to release, to set free what lives." (Deleuze, 1983, p.185) This will lead us to a nihilist society, where we are unburdened. The nihilist here is acting on skepticism to try to achieve perfect freedom,

which he considers to be a perfect goal as a liberation of the self is the ultimate good.

Pragmatic skepticism on the other hand is a skeptic point of view that is trying to avoid all of the potential painful consequences of acting on skepticism. This means that the pragmatic skeptic is satisfied enough with the current world (or at least with what can be achieved in the current world), that he doesn't want to risk it. The pragmatic side of pragmatic skepticism is what makes this so different from other forms of skepticism. Skepticism is a purely rational idea, because it will never intrinsically persuade us (there is a part of our thought that is irrational and that we don't have control of that will always take the world around us at face value). This means that if we live a purely skeptical life, it will be unpleasant because some part of us can't be convinced (and that's the part of us that makes life joyous or bad). Any attempt at rationally discrediting this unpleasantness won't change anything, because the unpleasantness isn't rational. Here pragmatism tells you to live life as though skepticism isn't true, as long as that is more practical. But what is practical in this now valueless and reasonless world, devoid of society? The unpleasantness mentioned earlier is the answer to this: hedonism. Here, hedonism means maximizing pleasure while minimizing pain, but not in the traditional sense. Hedonism has grown to mean attraction towards instant pleasure, and avoidance of all pain, but this doesn't have to be the case. This new type of hedonist is willing to suffer temporarily if it means having more pleasure later. Pleasure here is anything that we think is positive or pleasurable, so the pragmatist, like anyone else, can still follow intrinsic feelings of righteousness if overall it feels better to do so. Thus, the pragmatic skeptic, although rationally a skeptic, will live his life as he would normally, because pragmatists don't see reason as some underlying truth. It is important to note that, while the nihilist focuses

skepticism on society values, and reason, the pragmatic skeptic can be applied more globally (and so also contrasts Pyrrhonian skepticism, which is acting on the doubt of the existence of the physical world).

A possible critique of nihilism, and one that would be proposed by the pragmatic skeptic, is how the nihilist knows that the world will be better after we remove all baseless, or at least constricting, values from society. Nihilism proposes two possible answers. The first is that creating a society that isn't based on false or unprovable claims has to be better, because it doesn't impose things on us, or limit our freedom. As Vattimo (2009) said, "there are no ultimate foundations before which our freedom should stop." (p. 21) The second is that, after destroying everything, we will get an opportunity for improvement that is impossible to get right now, because we are trapped by society and reason. The issue with the first argument is that the proposed perfect freedom is unachievable. As humans, we are stuck with our reason, our impulses... that control how we act. We created (or some would say discovered) values, societies, and God because of our natural predispositions (although many values and parts of society are our rational conclusions to these basic impulses). Because we can never get rid of our natural thought process or impulses, we will either just be putting ourselves back at square one, which will lead us to a similar situation as we are in now, or we effectively get rid of society and values, but still be considered restricted by reason and impulses, making everything futile. While, as proposed by Vattimo, one could argue that perfect knowledge would lead to perfect freedom, the physical part of our thought (like our senses giving us potential knowledge) restricts us from ever knowing if we can truly have knowledge. A pragmatic response to the second argument is that, as society has progressed, our lives have become more pleasurable and more free (in the

long run, so here the pragmatic skeptic is ready to sacrifice some pleasure for the advancement of humanity, because that in and of itself is pleasurable), therefore why should we take a 'high risk, high reward' path when we can just go slowly and risk very little. Both of these counter-arguments highlight the core of the disagreement between nihilists and pragmatic skeptics: nihilism says it's doing what's necessary, while pragmatic skepticism says it's doing what best (hedonistically).

Nihilism wouldn't be such a developed and, in some cases, accepted train of thought if it didn't have answers to the critiques above. The first, as mentioned in the explanation of nihilism at the beginning, is negative affirmation. The destruction of our baseless world isn't some brutal uprising (although it can be), but rather a removal that makes things get better. Another rebuttal is that, from our impeded spot, we have no real way of understanding what this better world looks like, and thus there is no comparison to the gradual improvement offered by the pragmatic skeptic. The most important nihilist argument in this case is that nihilism is built in opposition to what is called the 'evil triad': the slave, the tyrant, and the priest. The first impedes his own liberty by taking comfort in his oppressed role, the second impedes the liberty of others through force, and the third makes others impede their own liberty by tricking them. Deleuze (1980) rhetorically asks "what is there in common between a tyrant who has power, a slave who does not have power, and a priest who seems only to have spiritual power", saying that "they need to make sadness reign because the power that they have can only be founded on sadness" (last argument of the class). Our current values allow these three to exist, and therefore anything less than their total removal is wrong. Pragmatic skepticism would be considered by nihilists as compliance and submission to these people who derive power from something negative.

This possibility for compliance is what makes pragmatic skepticism better than nihilism. Pragmatism in the face of skepticism is, in and of itself, compliance. This compliance is better because it allows progress, where nihilism advocates for abrupt change. In the end, nihilism doesn't actually give any proof of a better world, and thus compliance seems better than risking everything. People want better lives, and so radical change isn't necessary where slow but consistent improvement is possible. While it is sometimes important to change quickly (as humanity has done a few times when it needed to adapt), it has never been necessary to remove the possibility of going back. From a hedonist point of view, good progress (progress being utilitarian, a sort of hedonism on the scale of society) brings people basic pleasure (like a life with fewer hardships) and the pleasure that comes from knowing that others are suffering less. There is no 'better world', we just slowly make more and more progress, veering towards a non-existent perfection. Compliance is by no means a perfect reaction, but rather it is an inherently negative one. Nonetheless, it is the lesser of two evils when compared to nihilism risking everything. Slow progress allows us to, over time, have less painful lives, while also never risking too much. Historically, our lives have gotten better and better (better here meaning more pleasurable), faster and faster. We must accept that our purely rational conclusions about the world aren't the best bases for living. As mentioned earlier, no matter how rational you are, you still feel pain and pleasure. We take pleasure in some parts of society, in following our values, or in doing the perceived right thing. We also get pain from change and removal of our current life, as well as from not following our intrinsic (stemming from a Darwinist need for societal life, so not necessarily right or wrong) values. Rationally, compliance allows us the most improvement.

Using a natural tendency towards hedonistic progress still isn't an argument against the nihilist, who would call this all a basic infringement on freedom, and so something wrong. This nihilist response is what really makes nihilism lose any credibility. The best way to illustrate this is through three pragmatic skeptic counter arguments:

1. What right does the nihilist have to call something wrong?

Nihilism rejects all of our current morals and our societal judgment, so it can't deem anything right or wrong. How does the nihilist know what to do, when he would also say that he is blinded by society, reason, and impulses? Nihilism is such an extreme form of skepticism that it discredits the supposed foundations of everything, including its own argument.

2. Nihilism is impossible because our identity is stuck in the world it wants to destroy.

The perfect nihilist desires nothing and is no longer subject to the will of other things. This means that should we achieve perfect nihilism, we would just all die. A very simple example is eating: in many cases we eat because we are hungry, but that's an impulse more than a thought from an individual. Perfect nihilism would release people of all impulses that aren't part of the self, and therefore we wouldn't eat and would die because we don't consider hunger part of our identity (this is an extreme example that seems ridiculous, but it does highlight the impossibility of not being subject to anything). Even the nihilist would have to agree that death is bad, at least insofar as it impedes our freedom (if a nihilist said that death was the perfect liberation rather than a restraint, then he would consider it optimal to die rather than change the opinions of others). This shows why nihilism is impossible. From a Darwinist perspective, most

of our basic impulses are built off of a need for survival, as is the core of most societies. If we get rid of this, then we get rid of our most fundamental thoughts. More importantly, our identity and thought is based on the fact that rational thinking can allow us to find better ways to follow our basic impulses. The very impulses that we are trying to dispossess are the reason we have an identity. This means that, even if we managed to get to a perfect nihilist world, we would die or lose the identity that we wanted to free.

3. Perfect freedom for several people is impossible.

While the pragmatic skeptic is an advocate for freedom (because we find freedom pleasurable), he still cannot agree with the pragmatic skeptic because perfect freedom isn't possible. Even ignoring the physical tethers on our minds, from the moment two people have perfect freedom, one can impede the freedom of the other. This is why, in keeping with our natural attraction to progress, we have created more Lockean societies. We choose to give up some freedoms (like the freedom to impede on other's freedom) if, in response, others do the same. In most societies, someone can't murder someone else because most people prefer to avoid the risk of being murdered rather than be able to murder. If perfect freedom were possible for several people, we wouldn't need these compromises in society. The pragmatic skeptic on the other hand can adapt to our current Lockean (but also republican and capitalist) society by seeing it as an improvement on societies that came before.

Conclusion

The only form of skepticism that seems to work is the one that ignores it. Nihilism shows the issue with trying to act on skepticism. If nothing is predictable and nothing is

knowable, any attempt at a conclusion will be easily taken down. Nihilism is so appealing because it rejects everything while still having a very human end goal: freedom. Nihilism is almost hopeful, and in some ways follows our current values more than the pragmatic skepticism, even though it accuses pragmatic skepticism of doing the same. Nihilism can't be considered a legitimate response to skepticism because it only looks at the parts of skepticism that help its argument, but not the ones that go against it. Pragmatic skepticism, although it can end up leading to a utilitarian good, shows how it is sometimes necessary to go against innate (or societal) morals, walking a fine line between potential harm and contradictory values. Therefore, the only way to be a skeptic is not to live in accordance with that rational conclusion.

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The Relationship between Color and Morphology of Galaxies with Redshift

By Andrew Yu

AUTHOR BIO

Andrew Yu is a student at Jasper High School in Plano, Texas. This paper derives from the research at the High School Research Academy at the University of Texas at Austin over the course of the summer of 2022, and from science fair research in the school year afterwards. Andrew is an enthusiast in astronomy, math and computer science. He is the president of Teen TAS, a student organization part of the Texas Astronomical Society intended to stimulate interest and passion for student astronomers through group and self-led activities in astronomical observation, research and community outreach. Andrew is a qualifier and top 50 finisher of the National Astronomy Competition of USAAAO (US Astronomy and Astrophysics Olympiad) and a five-time qualifier for the AIME (American Invitational Mathematics Exam). He also enjoys sharing his knowledge in astronomy and math by regularly teaching younger students.

ABSTRACT

The research topic derives from the author's deep curiosity in galaxy evolution. He is asking if there is a correlation between the distance to a galaxy (measured by its redshift) and its color, measured by $u-v$ (ultraviolet magnitude subtracted by visible light magnitude) color index, for galaxies of various morphological types (spirals, ellipticals or irregular shapes). Astronomical data such as redshifts, morphological types, and color indices were queried from the database SIMBAD and calculated. Python was used to perform data analysis and to graph data. The best fit function was deployed for polynomial regression with different polynomial degrees to determine the best fitting trend. One-directional trending was not seen throughout, rather, a complex pattern roughly represented by $y = -0.027x^4 + 0.150x^3 + 0.053x^2 - 0.453x + 1.192$ was identified. The downward trend originally hypothesized was present only in the redshift ranges $z < 1$ and $z > 3$. The study showed that for each morphological type, there is not a simple correlation between a galaxy's distance and its color index. However, a cross-morphological type comparison indicated irregular shaped galaxies are bluer than spirals, and spirals are bluer than ellipticals, which was the case throughout the entire redshift range.

Keywords: SIMBAD, Galaxy classification, morphological types, redshifts, color index, polynomial regression, python, star formation.

INTRODUCTION

Galaxy morphology is used by astronomers to categorize galaxies based on their shapes. The most famous classification is called the Hubble sequence, visualized in the Hubble tuning fork, categorizing galaxies into three categories. There are spirals, which have a structure characterized by a disk of spiral arms, which have active star formation regions, and a bright, glowing bulge at the center without the necessary gas and dust to create new stars. Other galaxies, called ellipticals, are less structured: simply an elliptical halo of stars orbiting around a compact center. Ellipticals do not form stars in great quantities. In between the two is a category called lenticular galaxies, which are not purely spiral or elliptical but have similar characteristics to both. Finally, the last category is irregular galaxies, which as the name implies, do not fit in the first three categories. They usually have properties similar to the spiral arms of spiral galaxies, having high star formation rates (Buta et al., 2015).

Color

Many researchers studied the Hubble Sequence with the observations of star formation rates (SFR) based on integrated light measurements in the ultraviolet (UV), far-infrared (FIR), or nebular recombination lines, also simply known as the color of the galaxies (Kennicutt, 1998). Color is important to a galaxy because it can help reveal the populations of stars in the galaxy and the galaxy's star formation rate. High-mass stars are brighter and bluer than low-mass stars, which are red and dim. Luminosity is proportional to mass to the $3\frac{1}{2}$ power ($L \propto M^{7/2}$), and since the amount of time a star shines is roughly its mass divided by luminosity, the higher the mass a star

is, the shorter the amount of time it will live. Combined with the fact that blue stars are usually brighter than red stars, this means the blueness of a galaxy indicates the galaxy's star formation rate. Established astronomical research has indicated there is a strong correlation between color and morphology (Smethurst et al., 2021) (Gusev et al., 2015). Spiral and irregular galaxies tend to be bluer than elliptical and lenticular galaxies (Skibba et al., 2009), meaning that spirals and irregulars undergo more star formation.

As we examine galaxies at very far distances, we look back into time, effectively allowing a glimpse of the earlier days of the universe through these distant galaxies. Data found on multiple distant galaxies enables us to study their evolution. A form of measuring distance, known as redshift, has become popular. Redshift is the lengthening of light waves due to the motion of the emitting galaxy away from the Earth because of the expansion of the universe, making its light redder than it would appear if it were not moving. It is calculated by dividing the observed wavelength by the known wavelength at certain critical emission lines, and then subtracting 1. For example, if a galaxy's hydrogen-alpha emission lines were observed to be triple the wavelength observed in our own galaxy, the redshift of that galaxy would be equal to 2. At very far distances, which this paper includes, the theory of special relativity must be used to accurately determine the recessional velocity, in the following formula: $z = \sqrt{\frac{1+v/c}{1-v/c}}$, where v is the velocity that the galaxy is moving away from Earth.

While extensive analysis on galaxy colors at all morphologies and redshifts have certainly been done, the big picture is still far from complete. For one, little is known about the internal workings of galaxies in the early era of the universe, and what caused such transitions of

star formation to form. New discoveries, especially at further redshifts, could be made, allowing a clearer understanding of how our universe today came to be. Though some ideas about the process can be gathered from spectra (Kewley et al., 2019), galaxy evolution remains opaque to the observer.

The research question derives from the author's curiosity in galaxy evolution, asking if there is a correlation between the distance to a galaxy (measured by redshift) and its color for galaxies, and if this varies by morphology. I asked the question: "Do galaxies become bluer at higher redshifts?", with my hypothesis being that when the distance (redshift) of a galaxy increases, the blue-red color index of the galaxy, adjusted for redshift, will also increase. As the redshift of a galaxy increases, its color index should decrease (becoming bluer), regardless of the morphological type. We expect that after a certain distance from Earth, galaxies of all morphological types will become bluer, because at some point in the past, they needed to be forming stars at a faster rate than now to account for all of the older stars today.

MATERIALS AND METHODS

For the data in this project, I used the Set of Identifications, Measurements and Bibliography for Astronomical Data (SIMBAD), a database of extragalactic objects. I chose to use SIMBAD to find the collection of galaxies because it included data on morphological type, redshift, and color. In addition to SIMBAD, I considered using the Sloan Digital Sky Survey (SDSS), as it is one of the most thorough astronomical surveys conducted, and the NASA/IPAC Extragalactic Database (NED), one of the most comprehensive surveys for intergalactic objects. Eventually, I determined that the SIMBAD data was most accessible to begin addressing my question.

I queried SIMBAD with galaxy measurements of morphology, redshifts, and color index. I used the Hubble morphological scheme for galaxy classification of shape: elliptical, spiral/barred spiral, irregular, and then processed each classification separately.

	A	B	C	D	E	F	G	H	I	J
147	150	LEDA 74755E	AGN	0.10378	18.83	17.699	17.3	S E 2011ApJ...727...83M		
148	151	EIS-DEEP CD1	EmG	0.4384	22.7651	21.764	20.2037	Sab D 2014ApJ...794...156R		
149	152	[HSN2014] 6	AGN	0.0874	21.25	19.64	19.11	S E 2011ApJ...727...83M		
150	153	2dFGRS TGS	EmG	0.0746	19.78	18.2213	17.419	Sab D 2014MNRAS.437.1698M		
151	154	2MASX J033	EmG	0.07593	19.55	17.6891	16.891	S E 2011ApJ...727...83M		
152	155	ACS-GC 9004	QSO	0.454	22.0732	21.9232	21.497	Im D ~		
153	156	CKOCDFS J05	EmG	0.4345	23.3276	22.7276	21.53	S D 2014ApJ...794...156R		
154	157	NGC 1317	GIP	0.006438	12.2	11.78	11.02	S0ar D ~		
155	158	NGC 1326	GiG	0.004584	11.69	11.43	10.54	S0a D ~		
156	159	NGC 1365	SyI	0.005476	10.48	10.08	9.63	S0(b) D 2013MNRAS.428.1927C		
157	160	NGC 1316	GIP	0.005911	9.81	9.15	8.53	E D 2014MNRAS.437.273K		
158	161	NGC 1393	GiG	0.007308	13.41	13	12.02	S0 D ~		
159	162	NGC 1383	GiG	0.006538	13.81	13.45	12.47	S0 D ~		
160	163	NGC 1400	EmG	0.001769	12.48	12.01	10.96	E1/S0 D 2014MNRAS.442.1003P		
161	164	NGC 1394	GiG	0.014126	14.28	13.66	12.81	S0 D ~		
162	165	NGC 1391	GiG	0.014457	14.79	14.25	13.34	Sa D ~		
163	166	NGC 1385	EmG	0.005011	11.28	11.5	10.94	S0c D ~		
164	167	NGC 1375	GIP	0.002442	13.5	13.02	12.4	SAB0 D 2013MNRAS.431.3060E		
165	168	NGC 1373	GIP	0.004573	14.44	14.03	13.26	Sa D ~		
166	169	NGC 1374	GIP	0.004443	12.46	11.97	11.08	E3 D 2013AJ...146...67B		
167	170	NGC 1389	GIP	0.003336	12.8	12.39	11.5	S0 D ~		
168	171	NGC 1381	GIP	0.005917	12.9	12.47	11.5	S0 D ~		
169	172	NGC 1382	GIP	0.006091	13.19	13.79	12.92	S0 D ~		
170	173	ESO 358-33	GiG	0.00524	13.63	13.36	12.41	S0a D ~		
171	174	NGC 1379	GIP	0.004563	12.17	12.04	10.91	E0 D 2014MNRAS.437.273K		
172	175	NGC 1387	GIP	0.004229	12.18	11.75	10.69	S0 D 2014MNRAS.437.273K		
173	176	NGC 1386	GIP	0.002905	12.42	12.16	11.23	Sa D ~		
174	177	NGC 1380	GIP	0.00616	11.32	10.94	9.93	S0 D ~		
175	178	NGC 1404	GIP	0.006498	11.53	10.69	10	E1 D 2013MNRAS.435.2274W		
176	179	NGC 1399	BIC	0.004755	11.05	9.74	9.59	E1 D 2013AJ...146...160R		
177	180	NGC 1482	GIP	0.006331	13.15	13.14	12.15	SA0pec D 2013MNRAS.431.1823M		
178	181	ESO 483-13	G	0.003	14.91	14.23	13.61	9 D 2018MNRAS.479.4136K		
179	182	NGC 1392	GIP	0.003158	13.42	13.94	14.09	1 D 1996MNRAS.278.1025L		
180	183	ESO 486-21	G	0.002776	14.89	14.41	14.03	9 D 2018MNRAS.479.4136K		
181	184	NGC 1744	LSB	0.002477	12.43	11.9	11.41	7 D 2018MNRAS.479.4136K		
182	185	NGC 1800	G	0.00272	13.51	13.19	12.7	9 D 2018MNRAS.479.4136K		
183	186	ESO 362-9	G	0.003097	13.66	13.05	12.67	dG/r D ~		

FIGURE 1: Raw data from SIMBAD

I filtered the data onto galaxies, and then within galaxies, looking for magnitude in near-ultraviolet (300-400 nm) and visible light roughly corresponding to yellow-green (500-600 nm), abbreviated u and v; the measure of redshift, abbreviated as z; and morphological type. SIMBAD collected this data through color filters letting the aforementioned bands of a certain wavelength through. I categorized morphological types into spirals, ellipticals, and irregulars.

The first calculation was to find the u-v color: this color index measures how much brighter the yellow-green visible light is than the near ultraviolet light, and has been used to determine "redness" previously, such as in (Zhang and Deng, 2015). This method of color index subtracts the "visible" magnitude from the "ultraviolet" magnitude, so for example a galaxy with "visible" magnitude 14 and "ultraviolet" magnitude 16 would have a u-v color index of 2.

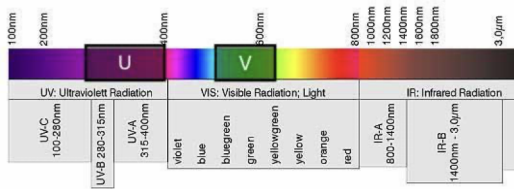


FIGURE 2: The rough passbands of the SIMBAD U and V color filters. Adapted from (Wavelength ranges of electromagnetic radiation)

The second calculation compared the u-v index against the redshift for a given galaxy. As redshift is a function of distance, I used redshift as a stand-in for distance on the x-axis, so in essence, I graphed color by distance. I then broke the data into spiral, elliptical, and irregular galaxies to compare the color by distance relationship for each galaxy type.

I conducted data analysis in Python 3 using Jupyter Notebooks instead of an IDE to run the code, as running chunks of code and visualizing the results right away is only possible with the former. I used the Python library Pandas for my manipulation of the data file and Matplotlib to make my histograms and scatter plots. I also used the NumPy library to handle data analysis.

The built-in best fit function in NumPy was used for linear/polynomial regression. Different polynomial degrees were applied to determine the best fit by finding the least square. Matplotlib was used for graphing. All polynomials referenced use my specific $x = \text{redshift}$ and $y = u-v \text{ color index}$ graph axes.

The solution minimizes the squared error

$$E = \sum_{j=0}^k |p(x_j) - y_j|^2$$

in the equations:

```
x[0]**n * p[0] + ... + x[0] * p[n-1] + p[n] = y[0]
x[1]**n * p[0] + ... + x[1] * p[n-1] + p[n] = y[1]
...
x[k]**n * p[0] + ... + x[k] * p[n-1] + p[n] = y[k]
```

FIGURE 3: Polynomial coefficient calculation

RESULTS

The data consisted mostly of low redshift ($z < 1$) galaxies, however, there were enough galaxies for a useful analysis up until $z = 3$, with sparse data after that. In total, exactly 1603 galaxies were queried from the SIMBAD database and used in the analysis, which is only a tiny fraction of the total number of galaxies in the database, as most did not have the necessary data needed to calculate the u-v color index.

I found several interesting yet inconclusive trends in the data.

- Between $z = 0$ and about $z = 0.2$, there is an upward trend in the u-v value, which shows an increased reddening as galaxies get farther away. Elliptical galaxies also appear to be redder than spirals and ellipticals at this range.
- Between about $z = 0.4$ and $z = 0.8$, there is a vague downward trend in the u-v color index, showing that these galaxies become less red with increasing distance.
- Between $z = 1$ and $z = 3$, the trend reverses, and u-v color index once again shows a positive trend, so galaxies once again become redder with increasing distance.
- After $z = 3$, despite the small sample size at this vast distance, the color index appears to trend downwards again, meaning that galaxies this far get bluer with increasing distance. Because of the small number of data points in this range, I suspect this is an artifact of the data rather than a true trend.

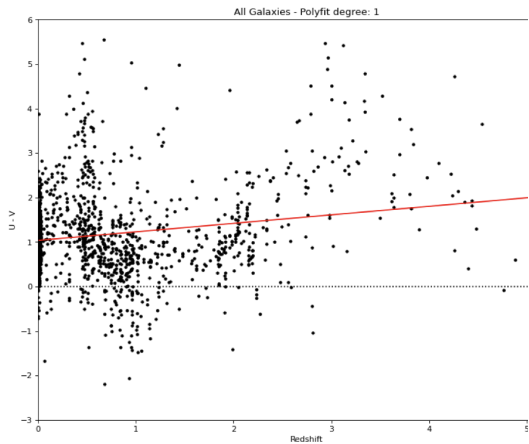


FIGURE 4: Polynomial regression of full data set, degree 1

Best fit line equation: $y = 0.192x + 1.036$

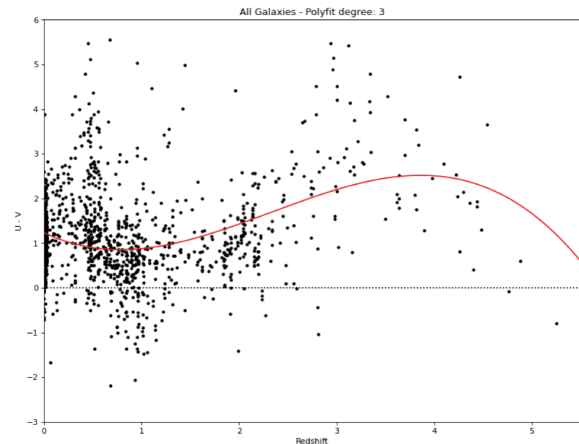


FIGURE 6: Polynomial regression of full data set, degree 3

Best fit equation: $-0.114x^3 + 0.798x^2 - 1.043x + 1.235$

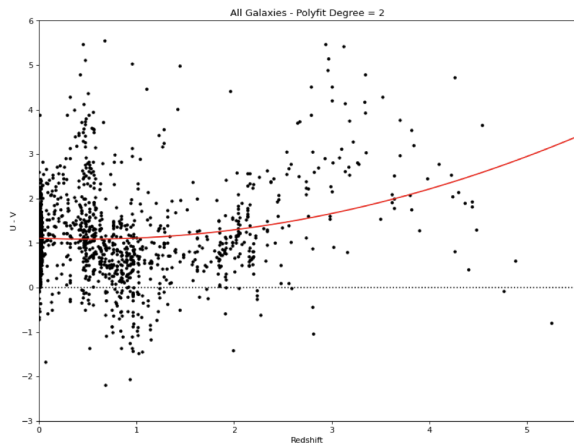


FIGURE 5: Polynomial regression of full data set, degree 2

Best fit equation: $0.091x^2 - 0.089x + 1.109$

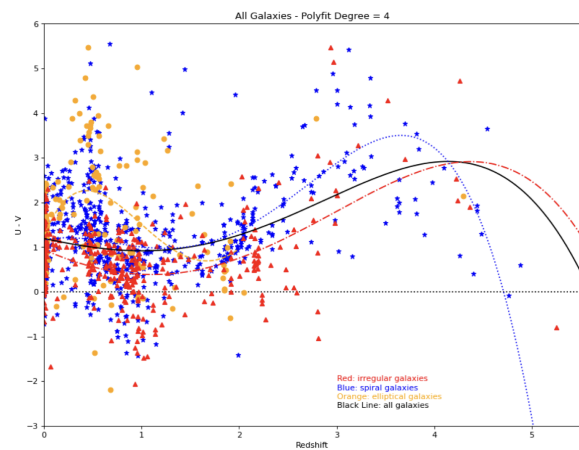


FIGURE 7: Polynomial regression, degree 4, separated by morphological type

DISCUSSION

The results are proven not as simple as a downward trending direction. Based on the above charts, one-directional trending was not seen throughout, rather, a complex pattern roughly represented by $y = -0.027x^4 + 0.150x^3 + 0.053x^2 - 0.453x + 1.192$ was identified.

- At low redshift ($z < 0.2$), the upward trend shows that galaxies do get redder

with distance, which is likely due to the effects of redshift itself altering the u-v color index value.

- Between $z = 0.4$ and $z = 0.8$, the downward trend aligns with my initial hypothesis, but it is not clear why this specific bound has a downward trend and not before or after it.
- The upward trend resumes between $z = 1$ and $z = 3$, which may again be due to redshift or some other unexplained factor.
- After $z = 3$, if the downward trend is truly valid and not due to a data collection artifact, this may also align with my hypothesis about the early universe having younger and bluer stars.
- The study showed that for each morphological type, there is not a simple one directional correlation between a galaxy's distance and its color index. However, cross morphological type comparison indicated irregular shaped galaxies are bluer than spirals, and spirals are bluer than ellipticals.

With several trends present in the data, the hypothesis was proven to be not entirely correct. While I was expecting mostly graphs trending in one direction throughout, the redshifts displayed a complex pattern roughly represented by the polynomial previously given. The downwards trend that I was expecting was present only in the redshift ranges $0.2 < z < 1$ and $z > 3$. This was a trend that held up across all three morphologies, though data for ellipticals were so sparse past $z = 2$ that accurate conclusions cannot be drawn for them. Interestingly, a similar trend can be seen in the reference papers, so further investigation will be required to confirm reasons for these patterns.

Finally, my initial hypothesis on irregulars being bluer than spirals, and spirals

being bluer than ellipticals, turned out to be correct.

My findings showed a few preliminary relationships, namely the positive trend at $z < 0.2$ and $1 < z < 3$, and the negative correlation at $0.4 < z < 0.8$, but further investigation is needed to prove these trends. Further research could compare more specific types of galaxies (comparing different types of spirals, ellipticals, or irregular galaxies in addition to lenticular galaxies as opposed to just the three main types) and a broader range of color indices (including blue and infrared filters, in addition to the ultraviolet and visible filters considered here). Finally, I would welcome a dataset from a different source (such as SDSS or NED) with a greater quantity of galaxies with very high redshifts. The lack of explanation for the findings is not conclusive, and I look forward to continued research.

Further research can be conducted as such:

- Use different color indices like u - g or g - v to determine if there are any differences in trends.
- Use machine learning libraries like Pytorch to predict properties of galaxies through already identified trends.
- Use software to simulate evolution of galaxies themselves and watch if it matches up to the data collected.
- Possibly, extend color indices to other areas of the electromagnetic spectrum (gamma rays, X-rays, infrared), which could tell us additional information about galaxy evolution.

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Utilizing Type II Restriction Endonucleases (EcoR1 and BamH1) in Complex with gRNA for Precise Gene Editing

By Matthew Platzman

AUTHOR BIO

Matthew Platzman is a driven high school student from New Jersey. Despite his passion for competitive soccer, his true passion lies in research. Matthew has researched at Brown University, where he integrated quantitative proteomics for protein profiling. Currently, he is working at the NEPS Lab at Tufts University's HNRCA, where he's researching heterogeneity in muscle mass 's with resistance training for sarcopenia. Matthew also worked at the Rutgers Waksman Institute, where he researched the potential of *landoltia punctata* for bioremediation and published 6 DNA sequences via NCBI. He gained valuable experience working in a human cadaver laboratory at the University of Connecticut. Matthew has proven to be a diligent and passionate researcher with an eye for detail. He's dedicated to making meaningful contributions to the scientific community and is driven to pursue a career in scientific research. He enjoys sports and spending time with friends and family in his free time.

ABSTRACT

CRISPR-Cas9 is one of the leading and most commonly employed gene editing processes. This technique uses guide RNA (gRNA) to recognize and excise specific DNA sequences. However, this process frequently elicits off-target effects within the genome. In consequence, the future of CRISPR-Cas9 as a therapeutic remains uncertain. This review aims to provide a new perspective on an alternative to the specificity, efficiency, and safety of genome editing by using type II restriction endonucleases, EcoR1 and BamH1, to recognize a specific DNA sequence (the recognition site) and cleave the targeted DNA adjacent to or within the recognition site. This article discusses the potential of utilizing intrinsic properties of these restriction endonucleases and repurposing them to prevent off-target mutations that may result in cancers. Preliminary research exhibits the specificity of using restriction endonucleases, however, it remains understudied in the field of cancer therapeutics. This review focuses on the potential to employ EcoR1 and BamH1 to prevent DNA sequence mutations during gene editing.

Keywords: EcoR1, BamH1, restriction endonuclease, enzymes, CRISPR-Cas9, gene editing, DNA, cancer, genetics, molecular biology.

INTRODUCTION

In 2020, the Nobel Prize for Chemistry was awarded to Emmanuelle Charpentier and Jennifer Doudna for their resounding discovery of CRISPR-Cas9 genome editing (Westermann et al., 2021). Cas9, an RNA-guided enzyme employed in the CRISPR-Cas9 gene editing process, is adapted from an innate genome editing system found in bacteria (Guo et al., 2022). The process, although complex and precise, can be simplified and visualized as 4 steps: (1) the Cas9 enzyme configures a complex with the gRNA in a given cell, (2) the Cas9-gRNA complex attaches itself to the corresponding DNA sequence of the gRNA adjoined to a spacer, (3) the complex then ‘snips’ the double-helix, (4) DNA sequences are inserted into the genome, replacing the excised segment. There are 3 different ways CRISPR-Cas9 can be used: disruption, deletion, or insertion (Xu et al., 2020). Disruption is used to induce base pair changes that prevent the expression of certain proteins and biomarkers, while deletions remove portions of the genome, and insertion replaces DNA segments. This process is operated by utilizing Cas9, an endonuclease. A restriction endonuclease is derived mainly from certain strains of bacteria, such as *Escherichia coli*, and has the capability to cleave DNA segments with higher specificity and sensitivity.

However, Cas9 is not a *restriction* endonuclease. Thus, Cas9 is prone to cause mutagenesis within off-target sites within the genome (Guo et al., 2023). This review article pinpoints why CRISPR-Cas9 elicits off-target effects and introduces alternative techniques utilizing type II restriction endonucleases EcoRI and BamHI to prevent unintended mutagenesis. Specific genes have been targets of gene editing techniques due to their tendency to cause carcinogenesis. The BRCA1 gene was originally

discovered in 1994 and the BRCA2 gene in 1995 (Makhnoon et al., 2022). Both BRCA1 and BRCA2 are tumor suppressors, encoding proteins that regulate cell growth and proliferation. BRCA1 has been found to interact with multiple DNA repair and recombination proteins such as Rad51, the Rad50-MRE11-Nibrin complex, Bloom’s helicase, and the Fanconi D2 protein (Murthy et al., 2019). The specific role for BRCA1 within transcriptional regulation and proliferation is exemplified through interactions with CtIP, ER (estrogen receptor), HDAC, Rb, p53, RNA polymerase II holoenzyme, cyclin D1, and c-myc (Murthy et al., 2019). Estrogen-responsive organs, such as the ovaries and the breasts, are at major risk when it comes to BRCA1 mutations. 55%-72% of women who inherit a *BRCA1* variant and 45%-69% of women who inherit a *BRCA2* variant will develop breast cancer between the ages of 70-80 (National Cancer Institute, 2020). Carcinogenesis will only occur when both alleles of BRCA1 and BRCA2 are mutated (Godet et al., 2017). Since BRCA1 is located on chromosome 17 and BRCA2 on chromosome 13, it is possible for mutations to be inherited by both parents as both genes are autosomal (Petrucci et al., 2016).

Methodology and Results of SpCas9-Mediated Off-Target Mutations in the vas-7280^{CRISPRh} Strain

In 2021, the Simoni Lab published their findings in the *Proceedings of the National Academy of Sciences (PNAS)*, where they determined the rationale behind off-target mutations correlating to CRISPR-Cas9 editing (Garrood et al., 2021). The Simoni Lab used mosquitoes (*Anopheles gambiae*), which are vectors for human malaria (Garrood et al., 2021). They compared the propensity of off-target mutations in four different gene-drive

strains. A gene-drive causes certain strains to inherit genes more frequently than Mendelian genetics would allow for. In the first strain, they used a non-germline restricted promoter from *Streptococcus pyogenes* (SpCas9), a gRNA, and two recognition sites in the mosquito genome. Under these conditions, the frequency of off-target mutations reached 1.42%, which is considerably high at the microcellular level (Garrood et al., 2021). To identify off-target mutations of gRNA that targeted the gene *AGAP007280*, the Simoni Lab used CIRCLE-seq (Garrood et al., 2021), which is characterized by its circular structure for research of cleavage effects. Using the CIRCLE-seq process, the researchers discovered that there were 98 off-target effects apart from gene *AGAP007280* (Garrood et al., 2021).

They selected the top 15 off-target mutations with the highest CIRCLE-seq read counts and 5 additional sites to gauge whether the off-target mutations in the assay displayed evidence of insertion and/or deletion of nucleotides (Garrood et al., 2021). They then used targeted amplicon sequencing, which allows for the analysis of genetic variation, on pools of mosquitoes to search for the intended on-target sites to be cleaved (Garrood et al., 2021). 19 of the 20 total sites returned sequencing reads—the remaining site was excluded from the experiment due to the inability to be sequenced (Garrood et al., 2021). An additional site was removed from the experiment due to highly repetitive sequencing and polymorphisms (Garrood et al., 2021).

Within the on-target sites, there were many mutations in 3 strains targeting *AGAP007280* (Garrood et al., 2021). Using the strain that was predicted to cause the most sensitivity, *vas-7280^{CRISPRh}*, the Simoni Lab uncovered insertions and deletions (indels) above the threshold frequency at five distinct sites (off-2, -4, -6, -11, and -19) in all 5 sample generations (Garrood et al., 2021). Under these

conditions, indel frequencies ranged from 0.03% to 1.42% of the total sequencing reads per off-target mutation site (Garrood et al., 2021). Four of the five sites were found in introns or exons, (*AGAP000774*, *AGAP011092*, *AGAP000061*, and *AGAP000042*), all of which had four or fewer discrepancies with the on-target sites (Garrood et al., 2021). Studies indicate that wild *Anopheles* mosquito populations show high degrees of polymorphisms within their genomes (Garrood et al., 2021). Several of the studied sites exhibited off-target mutations within the *vas-7280^{CRISPRh}* gene-drive population and had several allele variants; this impacted off-target cleavage through the formation of sites that resembled on-target sequences (Garrood et al., 2021).

The Simoni Lab tested the hypothesis that different innate polymorphisms can affect mutation frequencies at off-target sites (Garrood et al., 2021). They analyzed the relationship between indel frequencies and the presence of single nucleotide polymorphisms (SNPs) in sites made distinct by CIRCLE-seq (Garrood et al., 2021). The amplicon sequencing at the off-4 site displayed five total base pair mismatches with gRNA-7280 (Garrood et al., 2021). They analyzed the frequency of mutations for each individual allele and found that only the reference allele showed proof of cleavage, whereas no indels were found in the variant allele that had three mismatches (Garrood et al., 2021). The CRISPR-Cas9 process, although reportedly specific and sensitive, is actually faulty.

How EcoR1 can be Used in Complex with Programmed gRNA to Excise Mutated Sequences

EcoR1 is a type II restriction endonuclease isolated from *E. coli*. It cleaves double-stranded DNA into fragments with specificity and is a

part of the restriction modification system in prokaryotes, which defends against foreign DNA entry. EcoR1 binds and recognizes the sequence 5' GAATTC 3', cutting both DNA strands between the G and A nucleotides. EcoR1 is a homodimer of a 31 kilodalton subunit, having one globular domain being the α/β structure. By using time-resolved second harmonic (SH) generation spectroscopy, scientists were able to observe EcoR1 in real-time (Doughty et al., 2011). They discovered that the binding of EcoR1 to the recognition sequence of a 90 base pair (bp) DNA duplex attached to colloidal microparticles occurred rapidly (Doughty et al., 2011).

In the existence of cofactor Mg^{2+} , the researchers observed DNA cleavage, the detachment of EcoR1 from the DNA substrate, and the diffusion of the 74-bp fragment into the bulk solution that they ran, leaving the 16-bp fragment perfectly intact (Doughty et al., 2011). Since type II restriction enzymes cut at extremely specific recognition sites, enzymes such as EcoR1 can be utilized for precise cleavage in gene editing with gRNA. This gRNA will contain the palindromic complementary recognition sequence of 5' GAATTC 3' and be programmed to find the recognition site using targeted amplicon sequencing. Thus, when the gRNA-EcoR1 complex is inserted into the genome, it can effectively locate the target segment and attach itself adjacent to the recognition sequence. EcoR1 will begin cleaving adjacent to the site, excising the mutated base pairs.

How BamH1 Can complex with gRNA

BamH1, isolated from *Bacillus amyloli*, is another type II restriction endonuclease. It was found that BamH1 is remarkably similar in structure to EcoR1 in regards to their active sites (Newman et al., 1994). BamH1 recognizes short sequences of DNA, specifically the 6 bp

sequence 5' GGATCC 3' and cleaves adjacent to the 5' guanine (Adedeji Olulana et al., 2022). The cleavage results in sticky ends that are 4 bp long (Arzanova et al., 2022). BamH1 is composed of a central β -sheet, which resides between α -helices (Adedeji Olulana et al., 2022). BamH1 undergoes a series of conformational changes upon recognition sequence identification, allowing the DNA to maintain its innate B-DNA conformation without distorting itself to ease enzyme binding (Adedeji Olulana et al., 2022). Akin to EcoR1, the potential of utilizing BamH1 in complex with gRNA is compelling. This gRNA will be able to recognize the mutated sequence in the genome through targeted amplicon sequencing and will contain the palindromic recognition sequence 5' GGATCC 3'. The BamH1-gRNA complex will bind adjacent to a mutation in the genome and cleave the DNA segment. The BamH1 restriction endonuclease provides the field of gene editing with an alternative method of genetic manipulation to treat mutations in genes such as BRCA1 and BRCA2 that are associated with diseases and cancers.

Conclusion

The field of oncology is like a puzzle. Scientists and researchers are slowly completing the puzzle piece by piece. Gene editing is one of the leading techniques in the realm of genetics and biology, and its potential to alter protein expression can be leveraged in the field of cancer therapeutics. The current standard in gene editing, CRISPR-Cas9, commonly produces off-target effects that can be detrimental. As discussed, the Simoni Lab tested CRISPR-Cas9 gene-drives to determine whether this method induced off-target mutations in *Anopheles* mosquitoes. They compared the propensity of off-target mutations among the gene-drives, concluding that the CRISPR-Cas9 process frequently induces off-target mutations.

This review discussed the potential alternative of using EcoR1 and/or BamH1 in a complex with gRNA to mitigate the off-target effects caused by the Cas9 enzyme, which can be crucial in treating mutation-derived diseases such as cancer. Annually, 287,850 new cases of invasive breast cancer will be diagnosed in women and about 43,250 will die from breast cancer (Arzanova et al., 2022). In addition, breast cancer diagnoses make up 1/3 of all cancer cases in women each year in the United States (Breast Cancer Statistics, n.d.). The utilization potential of these two enzymes is limitless. Not only do the EcoR1 and BamH1 complexes provide higher efficiency and specificity in gene editing for cancer therapeutics, but this alternative method can certainly revolutionize the treatment of other mutation-derived diseases such as sickle cell anemia, Tay-Sachs, cystic fibrosis, and many more.

This efficient alternative method will shorten research and bench-to-bedside timelines since there will be much fewer unintended effects to correct. This alternative method is particularly exciting knowing that there are over 3000 type II restriction endonucleases. One can imagine using any recognition site of choice to direct cleavage for gene editing. Type II restriction endonucleases, such as EcoR1 and BamH1, can facilitate the advancement of research in genetics and all therapeutic fields.

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The Ethics of Dementia

By Gloria Chang

AUTHOR BIO

Gloria Chang is a student at Wycombe Abbey who hopes to continue research in medicine in the future. She started to get involved in research in 2022, with her first project centred around the development of and different treatment plans for breast cancer to help preserve the quality of life while prolonging life expectancy. She initiated this research to learn what ails her grandmother, a dementia patient, and figure out ways to alleviate her pain. In her free time, she enjoys photography, listening to music, playing the cello and hiking in nature.

ABSTRACT

Alzheimer's disease is the most common cause of dementia and one of the most devastating brain disorders suffered by the elderly. It can progressively affect patients cognitively and psychologically. Since the disease causes irreversible damage to the brain, various pharmacological treatments (galantamine, memantine, lecanemab) are used to slow down the progression of the disease and the decline of the patient's quality of life. However, the literature suggests that most treatments have shown more risks than benefits. This paper responds to the challenges by assessing the ethical implications of prescribing drugs that have a limited chance of improving the underlying condition. Many patients lacking capacity, such as dementia patients, have the right to use advance directives to communicate their wishes to the healthcare team in advance. Doctors in the UK also have to strictly adhere to the General Medical Council's principles to ensure decisions are made in the best interest of the patients. This paper argues that pharmacological intervention is not cost-effective, due to the various adverse drug reactions and the patient's declining quality of life. However, patients not using drugs will have a continuous progression in the severity of dementia symptoms, leading to a higher financial burden and increased demand for social care.

Keywords: Dementia, Alzheimer's disease, advance directives, medical ethics, lecanemab, galantamine, memantine.

INTRODUCTION

This review evaluates the risks, burdens and benefits of pharmacological intervention for dementia within the context of the British National Health Service (NHS). This paper attempts to make the decision-making process for prescribing drugs with various adverse reactions more transparent for patients and their families.

Methodology

This research was sourced from Google Scholar and PubMed; the paper utilises a qualitative thematic analysis to find commonalities between sources, all of which were published before February 28, 2023. Research was categorised using a qualitative thematic analysis method to find commonalities between sources.

Alzheimer's Disease

Dementia is a decline in mental ability severe enough to interfere with daily life, including the decline in memory, reasoning or other thinking skills (Alzheimer's Association, n.d.).

Alzheimer's Disease (AD) is the most common form of irreversible dementia. It accounts for 60 - 80% dementia cases and affects an estimated 850,000 people in the United Kingdom (Alzheimer's Association, n.d.). AD is a degenerative brain disease that is caused by complex brain changes following cell damage. It is not a normal part of ageing and leads to the decline of cognitive abilities, especially remembering new information. AD is most common in people over the age of 65, and it affects slightly more women than men (Alzheimer's Association, n.d.). AD is also a progressive condition with no cure, as it leads to

dementia symptoms that gradually worsen over time. However, there are medications to help relieve and slow down the progression of the condition (Alzheimer's Association, n.d.).

Pharmacological Treatments

There are three main pharmacological treatments targeted to Alzheimer's Disease: galantamine, memantine and lecanemab.

Galantamine (brand name Reminyl) is an acetylcholinesterase inhibitor which works by breaking down a substance acetylcholine in the brain, helping nerve cells communicate with each other. Galantamine is aimed at patients with symptoms of mild to moderate Alzheimer's disease (NHS, n.d.). It has proven efficiency in improving cognition, behaviour, activities of daily living, and global functioning (Onor et al., 2007). Adverse reactions are usually quite mild, including nausea and loss of appetite, and they occur in 20% of patients taking medication. It encourages a quick recovery time as patients usually get better after two weeks of taking the medication. (NHS, n.d.)

Memantine (brand name Namenda) is another type of treatment aimed at patients with moderate or severe Alzheimer's disease. It is especially suitable for those who cannot take or are unable to tolerate acetylcholinesterase inhibitors (NHS, n.d.). It works by decreasing abnormal activity in the brain by blocking the effects of an excessive amount of glutamate involved in brain functions, such as learning and memory (Ables, 2004). It improves the ability to think and remember or may slow the loss of these abilities in patients with Alzheimer's disease. However, memantine, like other drugs, cannot cure Alzheimer's Disease or prevent the loss of these abilities at some time in the future and symptoms may get gradually worse even with the medication. Adverse reactions are

temporary and include headaches, dizziness and constipation (NHS, n.d.).

Lecanemab, also known as Leqembi, is a new drug in its Phase III clinical trial. It is an amyloid beta-directed antibody that targets a protein, amyloid, which builds up in the brain in people with Alzheimer's (Li et al., 2016). It is aimed at patients with mild cognitive impairment or mild dementia associated with Alzheimer's disease (NHS, n.d.). It is the most successful drug observed and is proven to slow the rate of disease progression by about 20–30% after 18 months of treatment in patients with early Alzheimer's symptoms (Lecanemab, Memory and Aging Center, n.d.). The most common adverse reaction is an infusion-related reaction, such as flushing, chills, fever, rash and body aches. Another adverse reaction is amyloid-related imaging abnormalities with edema, or fluid formation in the brain. Studies with lecanemab show substantially lower rates of adverse reactions than other similar drugs (MacMillan, 2023).

Ethics of Prescribing on behalf of Patients with Impaired Capacity

There are ethical issues surrounding the prescribing of patients with impaired capacity. *Capacity* is the ability of the individual to make an informed decision free of coercion. This emphasises that respect for patient autonomy is a central premise behind the concept of informed consent and shared decision-making. It also supports patients in their decision-making process to give consent to or refuse medical intervention based on their values and information provided by the clinicians. A patient is presumed to have capacity to give or withhold consent unless it can be shown that there are grounds for thinking he/she lacks sufficient capacity. However, a patient with more severe dementia will lack the capacity to give consent.

Doctors prescribing for patients without capacity must follow the provisions of the Mental Capacity Act 2005 (Mental Capacity Act, 2005). It suggests that a patient is presumed to have capacity to give or withhold consent unless it can be shown that there are grounds for thinking he/she lacks sufficient capacity. In the case of an AD patient where it is almost guaranteed that they would lose their capacity, patients can use an advance directive to enable an individual to refuse a specific type of treatment at some point in the future (i.e. advanced refusal). Advance directives make provision for the donor (the patient) to appoint the donee (the advocate) in advance to make decisions relating to their health. This becomes effective when the patient loses capacity, so they can control their care for as long as possible. However, this does not confer the power to give or withhold consent, though it does confer the right for the donee to be consulted. The Act also suggests that it is legitimate to withhold and withdraw treatment or make an advance refusal of treatment if providing treatment is unlikely to benefit the patient overall, or if treatment prolongs death or causes unnecessary suffering, but does not include the right to demand for particular treatment or the right to die (GMC, 2010).

Clinicians registered with the General Medical Council (GMC) have to adhere to the ethical standards to ensure that decisions made are within the patient's best interest. The GMC's seven principles of decision-making and consent help doctors meet the standard of ethical principles that underpin good practice. It emphasises that all patients have the right to be involved in decisions about their treatment and care and to make informed decisions if they can. The exchange of information between doctor and patient is also essential to good decision making. Doctors must be satisfied that they have a patient's consent or other valid authority before providing treatment or care. The benefits

of a treatment that may prolong life, improve a patient's condition or manage their symptoms must be weighed against the burdens and risks for that patient, before you can reach a view about whether it could be in their interests (GMC, 2020).

Process of Decision-Making

The decision-making flowchart for treating patients with dementia is based on work done by Dr. Roger Worthington presented at an NHS workshop in 2020, subsequently published in *Clinical Teacher* (Worthington et al., 2020). This iteration is an interpretation of his decision-making process.

1. Establish what is known about the patient with consultation with the MDT and check to see if important information is missing.
2. Identify the ethical and legal considerations that arise with regard to clinical decisions needing to be made.
3. Consult with family members or carers to establish broad agreement on next steps.
4. Consider whether assumptions are being made.
5. Ensure all parties communicate with each other on a regular basis.
6. Identify risk, benefits, burdens associated with proposed course of action and discussing them with patient.
7. Check to see if alternate courses of action could be applicable to the case.
8. If necessary, consult clinical guidelines and seek legal advice before proceeding.
9. Try and ensure that current known patient wishes are being respected.
10. Once a decision has been made, make full, contemporaneous notes.

The Burdens of Pharmacological Intervention

The pharmacological treatments for dementia are designed to help delay the functional decline, but do not alter the course of the disease. Adverse drug reactions occur in up to 90% of patients with AD, and have a substantial impact on both patients and caregivers (Alzheimer's Society., n.d.). It is arguably unethical to treat AD patients with the medication due to their modest efficacy, high cost and little improvement in quality of life (Brenner, 2007).

Galantamine is a dual-reacting cholinergic treatment that improves cognitive performance and delays symptoms and caregiver stress. Although it is widely prescribed for AD patients, it has very high rates of treatment discontinuation and side effects; Jones et al. (2004) reported that 46% of galantamine-treated patients reported gastrointestinal adverse effects. It is also extremely costly and is estimated to cost 12 hundred dollars annually for one patient (NHS, n.d.). In comparison to the other treatments, its effects are more clinically relevant; Wilcock et al. (2000) found that two thirds of patients who received galantamine were judged to have improved or remained stable at six months. The side effects are also less severe with 92% of adverse reactions being mild to moderate in severity and only around 12% were serious adverse events. The results show galantamine is relatively successful in slowing the progression of functional decline in patients with mild to moderate AD and therefore also decreases the patient's need for care. However, the patient's quality of life will still decline from the high rates of adverse drug reactions.

Memantine is another pharmacological treatment that is approved worldwide for treating moderate-to-severe AD. Tampi & Dyck (2007) found that it made a small improvement on cognitive function, as no significant differences were observed with the addition of

the treatment. Its open-label phase (the phase used to compare treatments or gather additional information about the long-term effects in the intended patient population) further shows it has no effect on the underlying progression of the disease and often the rate of change in patients with moderate to severe AD accelerates over time until a stage of severe disease is reached (Leber et al., 2006). It is also not cost effective at around 18 hundred dollars (NHS, n.d.). Memantine shows the best profile of acceptability, but comes with serious risk if you don't take it as prescribed as symptoms often get worse quickly (Blanco-Silvente et al., 2018). The risks outweigh the benefits, providing a weak support for using memantine to treat patients with AD. This contrasts with the widespread use of memantine due to the lack of pharmacological alternatives for treating severe AD, leading to a significant burden on patients and their families and a considerable cost to society.

Of the three, lecanemab is the most successful in treating dementia and is likely to lead to a slowing in clinical decline from AD. Its Phase III AD clinical trial reported that it slowed the rate of cognitive decline by 27% in an 18-month study involving participants with early stage AD. It also has lower rates of adverse reactions with 21.3% of patients who received lecanemab having incidence of adverse events (U.S. Department of Health and Human Services., n.d.). However, it has the most severe adverse reaction as it often results in amyloid-related imaging abnormalities (ARIA) which may cause blood vessel leakiness leading to localised brain swelling and bleeding in the brain (Grabowski, 2023). It is also a new treatment so it is less accessible and there are less studies around its effect on memory and daily function. Lecanemab is also the only drug that is not approved by the National Institute for Health and Care Excellence (NICE), as only patients enrolled in the Phase III clinical trial

will receive it, so the costs are not covered by the National Health Service and patients have to pay around \$26,500 per year in the USA for just the treatment alone (Grabowski, 2023). However, the cost for medication only accounts for 5% of the total cost of care for treated Alzheimer's patients (Alzheimer's Society, n.d.).

All patients in the UK have the right to choose not to use pharmacological treatments which would increase caregiver stress and time of nursing home placement. The NHS covers the cost for both the galantamine and memantine treatments with tax payments, but does not cover the social care cost. The cost of dementia to the UK is currently £34.7 billion a year, which works out as an average annual cost of £100,000 per person with dementia. Two-thirds of this cost is currently being paid by people with dementia and their families or by selling the home of the patient, either in unpaid care or in paying for private social care. (NHS, n.d.)

Conclusion

The various benefits and risks of galatamine, memantine and lecanemab regarding Alzheimer's Disease range from relieving the psychological and behavioural symptoms of dementia to increasing the risk of other adverse drug treatments and decreasing the patient's quality of life. The best interest of the patient is ensured in accordance with medical ethics. Patients with capacity have the right of decision-making and refusing treatments, and patients without capacity can use advance directives to influence their course of treatment as long as possible if and when they lose capacity. Pharmacological intervention is not always cost effective if the risks outweigh the benefits. The symptoms usually get worse through the natural progression of the disease, but adverse reactions could impact on the quality of life with the expensive costs of both the treatments and the social care. However, without

the use of the treatments, the condition of the AD will continue to deteriorate, leading to an increased demand for costly nursing homes and carers.

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Analyzing the Failures of the Self-Strengthening Movement

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AUTHOR BIO

Jason Cao is a student at Choate Rosemary Hall in Connecticut. He is highly passionate about history and economics, and cherishes the opportunity to conduct original research. His field of expertise is modern Chinese history, and he is dedicated specifically to investigating late Qing economic, diplomatic, and political transformations. He enjoys finding common ground between events of the past and the present, especially regarding the broad political trends of China. Outside of academics, he spends his time playing the flute and composing original music. He also enjoys tutoring English to students from rural provinces in China, which allows him to expand his perspectives and give back to the community.

ABSTRACT

When analyzing the late Qing Dynasty, the Self-Strengthening Movement is often regarded as a significant attempt at modernizing China's military, education, and industry. Initiated by reform-minded officials like Li Hongzhang, the movement sought to reinvigorate China by applying Western knowledge and technology to traditional Chinese institutions. However, while the Self-Strengthening Movement did establish a comparatively modern military, institutions for Western studies, and a nascent industry, it lacked the depth necessary to bring substantive change to the nation. Indeed, the Qing Dynasty would continue to suffer military defeats and political turmoil that led to its eventual collapse. Through investigating the limitations of the Self-Strengthening Movement from three directions - military, education, and industry - this paper aims to highlight the structural issues that plagued modernizing initiatives. The paper attributes the eventual failure of the movement to the lack of systemic changes to China's political institutions. The need to adopt not only Western technology but also its democratic institutions remains applicable to China today.

Keywords: Self-Strengthening Movement; Qing Dynasty; Modernization; Westernization; Industrialization; China; Li Hongzhang; First Sino-Japanese War; Institutional Reform.

INTRODUCTION

In the early 19th century, China's status on the global political stage encountered a seismic shift. The arrival of newly industrialized Western powers by sea greatly altered the scale of China's interactions with the outside world. Prior to their arrival, China only had tenuous connections with the rest of the world as a result of its unique geographical position. The relative seclusion of the country fostered a Sino-centric worldview among its rulers, who were content with their empire and reluctant to pursue progress. However, upon the disastrous defeat in the First Opium War against Great Britain, China's closed doors were forcibly knocked open. Its leading officials soon became aware of the dire need to modernize.

Encounters

China was not at its best when it first encountered the Western powers. The feeble empire was heavily impacted by cycles of dynastic decay, which manifested itself in disastrous revolts like the Taiping Rebellion that caused untold damage to its most prospering provinces. Vested interests and conservative sentiments also dominated the Qing court, emphasizing traditional Confucian beliefs and resisting reform initiatives. These reactionary attitudes slowed progress and further deteriorated China's position in the world.

Following the Taiping Rebellion, a brief period known as the Tongzhi Restoration, which emphasized development, temporarily provided vitality to the Qing regime. During this period, reformist officials launched the Self-Strengthening Movement, a government-led initiative that hoped to change Chinese society through Western technology. Officials who supported Westernization, like Li Hongzhang, envisioned creating a modernized military and bringing Western inventions, such

as industrial machinery, to China. They hoped that through learning from the West, China could strengthen its economy and protect its interests on the global stage. However, while the Self-Strengthening Movement came from a place of good faith, its efforts were proven futile by China's humiliating defeat in the First Sino-Japanese War in 1895. The unprecedented defeat to a small neighboring nation revealed the significant structural issues that had plagued the empire, demonstrating the ultimate failure of the movement.

Further attempts at modernizing the nation failed as well. The Hundred Days Reform, a movement seeking to establish a constitutional monarchy in 1898, was halted due to a reactionary coup, reverting all hopes of a change in China's political system. In the ensuing Boxer Rebellion, foreign powers struck a major blow to the Qing Dynasty, forcing it to sign another series of unequal treaties. These events greatly undercut the power of the Qing government. After the defeat, the Qing Dynasty attempted greater constitutional reforms. Still, it was clear that their efforts were mere "window dressing" and that the ruling class had no intention of giving up power. With systemic reform rendered impossible, the people grew disillusioned with the corrupt and autocratic Qing government. A revolution finally broke out in 1911 that overthrew the regime and created a republic in its place.

Ultimately, reforms failed to prevent the collapse of the Qing Dynasty and the establishment of a republic. The eventual failure of the Self-Strengthening Movement and the grave disappointment of the people fueled the inevitable demise of the regime. The movement only treated the symptom of a lack of technology, but not the disease of backward systems and autocratic government, failing to deal with entrenched issues in Chinese society properly. The lack of systematic changes to the military, education, as well as commerce

coupled with traditional conservative beliefs led to the ultimate failure of the Qing Dynasty and the inevitable revolution that overthrew it. Through analyzing the failures of the Self-Strengthening Movement, this paper helps illustrate the fact Western technology and democracy are codependent on each other and that the establishment of modern political institutions is the prerequisite for societal progress.

Military Modernization

Ever since the beginning of the movement, importing military technology was of the utmost concern to Qing officials. China had been thoroughly defeated in the Opium Wars, and the enormous difference in military equipment was evident to its rulers. As such, modernization in the military was prioritized due to the need to quash internal rebellions and catch up with the West. However, while the hardware improved dramatically, deficiencies in military organization, training, and institutions would prove fatal in forthcoming wars. Ultimately, the lack of motivation to create a modern military that adopted Western systems as well as equipment led to China's disastrous defeat in 1895.

Demand for a powerful military was always strong during the late Qing Dynasty. In a time of international and domestic turmoil, a well-regulated modern army was necessary to maintain stability for the Empire. The Taiping Rebellion, one of the largest revolts China has ever seen, broke out in 1851 and served as a major catalyst for military modernization. The enormous scope of the rebellion forced the Qing Dynasty to purchase Western firearms that outclassed those of the rebels.

Apart from quashing revolts, national defense against foreign attacks was also a priority for the Empire. The doctrine of "using the techniques of the barbarians against

themselves" was promoted by Westernization supporters hoping for a stronger military. This facilitated the process of military modernization. At the time, the weapons of the Qing Dynasty were far inferior to those of Western powers. Regarding firearms, the Qing only had matchlock muskets that played an auxiliary role, while the British widely used flintlocks and caplocks as well as breech-loading rifled artillery. This advanced weaponry allowed the British to fire at a far greater rate and accuracy, which made their land forces much more formidable. In addition, the British also had a far superior navy that was industrialized and capable of firing powerful cannons with great accuracy. These advantages in technology motivated the Qing officials to purchase Western weaponry.

Apart from the arms purchases, China also sought to improve its weapon manufacturing capabilities by building its own factories. The largest of these was the Jiangnan Arsenal, established in 1865 in Shanghai, which built both ships and firearms. Foreign specialists led technical work in the arsenal, and soon it could produce large numbers of breech-loading rifles and artillery shells. The Jiangnan Arsenal also acted as a navy shipyard, producing both wooden and iron-hulled warships using Western technology. Because of the scale of the entire project, the arsenal became the largest weapons manufacturer in East Asia.

However, initiatives like the Jiangnan Arsenal met significant challenges as well. Most of the fleet that was produced paled in comparison to Europe's newest ironclad warships, which due to their strong armor, were impervious to ordinary shells. Ventures like the Fuzhou Dockyard were also deprived of imperial funding due to vested interests in the court that deprioritized military spending. This slowed the pace of production and hindered the pursuit of the newest technology. In addition, financial troubles starting in 1876-77 plagued

these projects as well. The large expenditures funding arsenals required led to widespread corruption and nepotism, aggravating the financial situation. As a result, these military projects were drained of funding and lacked the technological capabilities to produce weapons of the highest caliber. These issues slowed progress and allowed similar initiatives in Japan to surpass China technologically.

Although initial modernization attempts like arms purchases and manufacturing succeeded in quelling multiple internal rebellions, they failed to enact systematic changes to the military system itself. Much of the focus was on obtaining the best weapons rather than creating a well-trained, modern army. This would prove disastrous in China's shocking defeat in the First Sino-Japanese War in 1895, an incident widely seen as proof of the failure of the Self-Strengthening Movement.

Firstly, the Qing military was poorly organized. Unlike Japan, which had a unified fleet, China had multiple fleets in the North and South without a coordinated command structure. Fleets were reluctant to come to each other's aid, allowing them to be destroyed separately in the Sino-French and First Sino-Japanese Wars. Moreover, inadequate funding caused different organizations in the Navy to vie for resources, further deteriorating its quality. The supply command structure was also plagued with corruption, resulting in a shocking lack of ammunition during the war. The substantial disadvantage of a disorganized and poorly funded military resulted in an enormous naval defeat in the Battle of Weihaiwei.

Another significant problem the Qing military faced was insufficient training for its soldiers. While there were enough guns, soldiers were extremely incompetent in using them in actual battles. No systematic drilling program taught soldiers the necessary skills for modern warfare. Though equipped with rifles, armies still focused more on old Chinese drills with

spears and cold weapons than on learning to shoot straight and coordinate firepower. The officer corps were bastions against new innovations, being resentful of Western instructors and unfamiliar with modern warfare. As a result of the deficiency in training, army discipline was poor, and desertions were common, which greatly impacted China's military capabilities. The lack of commitment to adopting the full Western method of drilling, which Japan valued, made the disaster inevitable.

Instead of learning from the entire modern military system the West developed, the Qing Dynasty thought that only borrowing weapons would solve the issues. More entrenched problems like training regimens and military organization, vital for success in warfare, were not given the necessary attention they deserved, causing the military collapse. In comparison, Japan had completely revamped its military system and created government offices that would best lead a modern army. The comparison between the reluctance of the Chinese rulers and the willingness of their Japanese counterparts to embrace complete Westernization in the military was the ultimate cause of defeat.

Ultimately, China's military reforms during the Self-Strengthening Movement ended in a complete failure. The thorough defeat of the Chinese military during the First Sino-Japanese War demonstrated the futility of adopting Western firearms without similar military institutions. The same lesson China learned from its military could be extrapolated to many different fields.

Education:

Parallel to changes in the military, the Qing Dynasty also recognized the importance of revamping the Chinese education system. However, such efforts were even more limited in scale since Confucian texts and traditions were always prioritized. Despite hopes of modernization, officials continued to place

insufficient emphasis on familiarizing all students with Western subjects. As such, education systems strongly favored traditional practices, while efforts for institutions to respect science and embrace Western education remained highly inadequate.

Initially, educational reform came out of necessity since interactions with the West required relative proficiency in their languages. As part of a comprehensive Westernization program, Prince Gong established the Tongwen Guan, or School for Foreign Languages, in 1862. Students learned English, French, and Russian concurrently with Chinese to bridge the gap between China and the West. Moreover, as modernization created a strong demand for engineers and technicians, Western science subjects taught by foreign instructors were also incorporated. These included practical subjects like math, astronomy, chemistry, physics, and mechanics, which helped with efforts at industrialization and modernization. The cities of Shanghai and Canton established similar institutions to pioneer Western education in China as well. Graduates from these institutions would take up many integral roles in China's reform, becoming diplomats, translators, and notable businessmen.

Apart from education itself, efforts to translate foreign works were also underway to introduce Western learning and thought. The Jiangnan Arsenal, while a weapons manufacturing stronghold, was simultaneously a hub for classical scholars who were intent on bringing scientific and technical knowledge to China. Translation efforts prioritized works dealing with mathematics, military science, and manufacturing, producing hundreds of published volumes. These works were widely popular due to the strong demand caused by Westernization, selling over 30,000 copies in total. The Shanghai Polytechnic Institution also started publishing a new journal called the Chinese Scientific and Industrial Magazine to disseminate Western

science further. Focusing on natural science, the journal distributed translated works in over 20 cities in East Asia, always selling out in a few months. The more popular science presentations through the journal, accompanied by the academic translations from the Arsenal, quickly brought Western science to the main stage of Chinese society.

However, resistance to Western learning was still prominent. Conservatives within the Qing court were a strong political force that believed in the traditional concept of a strict boundary between foreign nations and China. The belief that new initiatives would destroy this boundary caused a significant backlash to the reforms. The primary factor that motivated the resistance was the prevalence of a "Celestial Empire" complex, the belief that Westerners were barbarians and that their knowledge lacked utility for China. In the opinions of these conservatives, all Western influence, whether in terms of culture or technology, should be prohibited. Another central assertion of the conservatives was that only tenets of Confucianism should be considered proper learning. All Western learning not introduced by ancient sages was considered non-essential and a deviation from true knowledge. This ideology was the foundation for the systematic opposition to Western education. Indeed, the Tongwen Guan was seen by many as a dangerous institution that had the potential to subvert the dominance of Chinese culture. They believed that the lack of a defined boundary between Western and Chinese learning was outrageous and objected especially to teaching math and astronomy. These beliefs were not exceptions but rather widely prominent in society, greatly limiting the scope of the reform.

Aside from traditional education methods, a more ambitious program brought greater controversy to Qing Dynasty educational reform. Between the years 1872 and 1875, the Qing government meticulously selected 120

boys between the ages of 10 and 16 to be sent to the US and fully educated in Western schools. The students focused on military affairs, math, and manufacturing, which officials considered the most practical subjects. They were dispersed into American families and continued their studies as ordinary students, immersing themselves in the local culture. Such a program was undoubtedly a great innovation at the time, allowing students to gain Western knowledge directly from its source. Supporters viewed it as a long-term venture that would benefit the nation when the students returned.

However, while the program was well-conceived, it encountered vociferous opposition within the Qing court. The overwhelming suspicion toward Western powers among ruling figures cast a massive shadow of doubt over the mission's prospects. Questions were raised about whether the students would retain the roots of Chinese civilization. Critics believed these children might be knowledgeable but would be “of no use to China” due to their lack of traditional values. The Qing commissioner for the project was particularly angry about the students refusing to prostrate before him, citing that as an example of the acquisition of foreign vices. The Americanization of the students also displeased conservatives, who saw it as a repudiation of Chinese tradition and morals. Eventually, in 1881, the pressure against the initiative forced Prince Gong to abort the mission and recall all the students in the middle of their studies.

For the students themselves, what awaited was a long period of disillusionment. Filled with grand ideas of reform, they came home to a government indifferent to their knowledge and hostile to their practices. An official described them as “runaway horses” who had to be “bridled” to become loyal and subservient. Hence, many students were assigned menial jobs and given tiny salaries, completely incomparable to traditional scholar-officials. Students

gradually grew frustrated with the tyrannical mandates and the backward practices as well, specifically prostration. The juxtaposition between their education in the US and their treatment within the Qing hierarchy gravely disappointed them. Admittedly, some students did eventually achieve prominence due to their technological expertise. However, they did so by subscribing to the political establishment and the patronage of powerful Qing officials like Li Hongzhang and Yuan Shikai. Overall, there was no system that allowed the Western educated students to shine and pursue their political reform goals, which could have led to a participatory democracy. Instead, dynastic politics absorbed them and stifled their hopes for reform.

Commerce and Industry:

Simultaneous to advancements in education and the military, the Qing Dynasty also sought to improve its commercial and industrial capabilities on the world stage. Officials saw the potential for Western technology to revolutionize not only China's military, but also her civil industries. Overall, the Qing court conceived of an import substitution strategy, with modernization initiatives designed to vie for a profit with Western companies. Instead of allowing foreign companies to flood the Chinese market, officials hoped to retain economic rights by manufacturing necessary goods themselves. Believing that closing the gates to the empire was no longer an option, they viewed commerce as a weapon to stop foreigners from deriving profits from China.

The advantages of this commercial strategy were evident. Officials recognized that the manufactured goods China imported were value-added products, which were more expensive than its raw material exports. By improving manufacturing, China could produce more industrialized goods with greater value in the international market. In addition, China also

had a great cost advantage due to its low price of labor, which would greatly decrease the price of domestic goods and increase competitiveness in the market. If China could manufacture products to the same standard as Western powers, then its decreased costs would allow it to dominate the market. However, officials ignored the crucial disadvantage of such a plan. Substantial exports in areas such as silk and tea were necessary to provide the funding that supported the introduction of Western science and technology to Chinese enterprises. With export processing sectors deemphasized China lacked a source for the capital needed to implement domestic industrial projects. As such, although the Qing Dynasty wanted to obtain the best technology and the most knowledgeable Western craftsmen, they lacked the funds to do so. Without the most advanced technology, the quality and price of domestic goods paled in comparison to those of their foreign counterparts.

The faltering silk production adequately demonstrates the failure of China's export sectors during the late 19th century. In 1873, China exported three times more raw silk than Japan, whereas, by 1930, Japan's exports were triple those of China. The unsatisfactory silk export statistics are quite shocking since China is widely known for its sericulture, with silk being one of its primary exports. Falling behind in the silk sector on the international stage showed a significant problem in China's development strategy.

Firstly, a lack of technology greatly damaged China's silk farmers. Japan widely promoted the most up-to-date sericulture technology by visiting Western countries and establishing modern research initiatives, while no such enthusiasm existed among their Chinese counterparts. While Japanese scientists reported extensively on the newest innovations, Chinese bureaucrats were much slower in distributing scientific works. Hence, significant technological advancements like the

microscopic method of disease prevention were largely ignored in China. Most silkworm eggs were entirely produced with traditional breeding methods, creating much lower quality and productivity cocoons.

In addition, a lack of commercialization also limited progress in Chinese sericulture. Before the 1890s, there were no modern machine-reeled silk factories in China, and most silks were still handmade. The question of the legality of private modern industries like silk factories in the Qing Dynasty meant that there was no encouragement for individuals to modernize and commercialize their silk farms. The lack of railroads and steamships in inner waterways also increased transportation costs, thereby decreasing production. All these issues caused by an insufficient commitment to modernization led to the failure of silk production.

With the efforts to create a stronger industry, another significant problem emerged - the ownership of modernized enterprises. While the government saw the importance of gathering capital from merchants through establishing joint-stock companies, they were more reluctant to relinquish the power to run these enterprises. For key projects important to the national economy, like railroads, the government insisted on retaining the power to construct and run the company. A parallel was made between managing a company and governing the nation. Officials believed that while the country could bring profit to businessmen and civilians, they could not be entrusted to rule it. Private merchants could manage less important trades, but government monopolies were established in key sectors like railways and steamships.

In such an atmosphere, the government facilitated the creation of a new company structure known as government-supervised and merchant-managed enterprises. Appearing in the 1870s, it reflected the government's will to raise capital from merchants while retaining absolute

control of the industries. In these joint-stock companies, the merchants provided all the funds based on public-private cooperation while the government acted as a temporary creditor. However, in the enterprise created, the merchants were only in charge of day-to-day management, with the government taking control of all overall decision-making. While such a structure was designed to ensure government planning, the significant imbalance in power put merchants at a substantial disadvantage. In these enterprises, the government almost always obtained direct control over operations, sidelining merchants. This caused the management of these companies to be highly inefficient, which greatly damaged the interests of the shareholders and obstructed modernization across the nation.

A prominent example of such an enterprise is the China Merchants Company, a steamship navigation company established in 1872. Providing transportation services in Asia using advanced steamships, the company was conceived as a vessel for commercial warfare. Before its establishment, Western enterprises like Russell and Company dominated the Chinese steamship transportation market and monopolized its profits. Officials believed that creating such an enterprise would end the Western monopoly in transportation. Indeed, the company was initially very successful. After its acquisition of Russell's fleet in 1877, it became the largest steamship operator in China, operating a large total of 30 ships. In the ensuing years, although it engaged in many price wars with Western companies like Butterfield and Swire, it was always able to gain a plurality of the shipping volume on prominent waterways like the Yangtze River. Its investment in other self-strengthening initiatives, most notably the Kaiping Mines, also showed its strong positive influence.

However, even the most successful example of the government-supervised /

merchant-managed structure encountered substantial issues. As a joint-stock company, the company did not have a stock exchange in which its shares could be traded. This made investing in the company more difficult and its business less transparent to shareholders. The loss of Li Hongzhang as the government patron due to his decline also led to internal strife and falling profits. Such was the danger of a quasi-nationalized company in an era of political instability. In addition, after the government opened the waterways for all enterprises, smaller firms took a substantial portion of the shipping volume. This showed the susceptibility of a government monopoly to free market competition. Overall, structural problems limited the commercial success of these government-supervised ventures and their societal impact.

Conclusion

Ultimately, the Self-Strengthening Movement initiated in the late Qing Dynasty was an impactful movement for the future of China. It successfully created a significant transformation in diplomatic attitude towards the West and brought advanced Western weapons to China. Notable achievements in adopting Western education and establishing competitive modern enterprises also brought significant change to the civilian sectors of society. These improvements were a meaningful first step for the ancient empire, laying the foundation for future developments.

However, the Self-Strengthening Movement failed to bring systemic change to China. Calls for implementing Western institutions like Parliaments continued to be ignored, while the military failed to completely modernize, suffering a humiliating defeat in the First Sino-Japanese War. There was also no intent to create an education system that prioritized Western learning and no hope of

developing a modern industry that prized technology and utilized an effective corporate structure. These downsides underscored the lack of fundamental change in the movement, limiting its scope and leading to its ultimate failure. In 1911, the people chose to revolt and create a republic instead of waiting on blank checks of reform.

Reflecting on the modern day, the failures of the Self-Strengthening Movement teach a grim lesson. While Chinese officials looked to the West for their superior technology and weapons, their arrogance and preconceptions hindered them from investigating further. They failed to see that modern institutions were also necessary, instead maintaining their view that only Western technology was notable. They continued viewing themselves as the “Celestial Empire,” demonstrating their reluctance to see others as equals. Hence, during the process of Westernization, officials maintained their doubt about the need for such an upheaval and resisted fundamental change. Such an arrogant attitude from reforming officials led to the eventual disaster. The stark comparison between the Chinese officials' condescending attitude and their Japanese counterparts' humility in the face of Western civilization showed the cause for the failed reform.

From a larger perspective, the lesson of the reform goes to show the greater truth that Western technology and democracy are codependent on each other. For a modernizing nation, it is impossible to only value superior Western technology, weapons, and science without adopting a democratic political system and universal values. Efforts to only reform the economy but not the social and political aspects of society fail to realize the fundamental cause of the strength of Western powers. Western institutions are the root of their advanced technology. For a developing nation, it is impossible to pick and choose between a strong industry and a vibrant democracy since a

developed economy and an autocratic government are essentially incompatible. The eventual failure of the Self-Strengthening Movement teaches the lesson that complete Westernization is the only plausible path to progress.

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Unnecessary Use of CRISPR in Medical Situations: Effects on Ethics, the Future, and the Environment

By Isabella K. Nguyen

AUTHOR BIO

Isabella Kim Nguyen is a student at Foster High School of Houston, Texas. She has been a participant in many activities including competing in the Technology Student Association conferences for many years as a participant and school officer, secretary as well as vice president, holding officer positions within two volunteering clubs, Interact Club and Green Club, as secretary and vice president and treasurer, respectively, that gives her the opportunity to be involved in her community, and assisting as a Pharmacist Technician Trainee. She hopes to pursue research into genetics or microbiology to receive her PhD at university after studying biochemistry in her undergraduate degree.

ABSTRACT

Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) has recently been used in situations that are considered unnecessary or not immediately life-threatening. An example of this situation are CRISPR babies, which have caused a great deal of discussion and uncertainty around this technology. This development puts the public at risk of data and statistics that have not been fully developed or researched despite many experts' urgency on making such technology widespread. This phenomenon may also bring the possibility of overpopulation as a result of a great increase in the quality of life.

Keywords: Cellular and Molecular Biology, Genetics, Genetics and Molecular Biology of Disease, CRISPR, CRISPR babies, Evolution, Gene Editing, Quality of Life.

INTRODUCTION

Evolution is an essential part of human and animal species as a means to survive and prosper. Humans, however, have grown to evolve much faster with the use of tools such as “clustered regularly interspaced short palindromic repeats”, more commonly known as CRISPR. CRISPR is a tool in genetic engineering that allows researchers and doctors to edit the genes of humans as well as animals and plants. This technology essentially copies pieces of RNA into a protein called CAS9 that cuts up the viral DNA of a bacteria's immune system (*CRISPR and the Future of Human Evolution*, 2017). Such revolutionary technology allows for the possibility of cutting out diseases like HIV and cancer cells, however using this on not immediately life-threatening diseases seems unnecessarily risky as they have other effective treatments. With the large unknowns of the side effects on health and the world, CRISPR's use in medical situations that do not find it immediately necessary should not currently become widespread.

Ethical Considerations

With the rise in gene-editing, such things as CRISPR babies have come to light. These children are called this because researchers have begun “changing the DNA of embryos before a baby is born in order to greatly reduce the baby's risk of developing serious diseases or health conditions over their lifetime.” (Marx, 2021) Though these diseases often have other treatable options later in life, many parents have begun opting into changing it down to the DNA as this also limits the hereditary disease from being passed down through generations. In a peer reviewed journal published by Nature Publishing Group in 2021, this use of CRISPR is stated as first beginning in a lab at Southern University in Shenzhen, China where He Jiankui conducted an experiment on two babies who were born with

genomes that were edited using CRISPR (Marx, 2021). This caused an uproar of conversations around the ethical implications of the experiments as there was little supervision of the experiment leading to his eventual arrest for ‘illegal medical practice’.

However, there were other possible drawbacks that will only be possibly seen as these babies grow up. Such drawbacks scientists have predicted are the possibility of these changes causing off-target edits in an intergenic region of chromosome 1 that has already begun in one girl's genome (Marx, 2021). The impact on real children with such new and largely unknown technology – namely CRISPR – when there is current treatment with more known data, brings to question the ethics of its potential drawbacks as well as changing a course of life for a family's generations through gene-editing. However, the current outdated scheme for biotechnology and regulations makes it difficult for scientists to undertake experiments to learn more about CRISPR babies. In *The Meditations of the Emperor Marcus Aurelius Antoninus, Book IV*, one of the rules to follow was “34. Willingly resign yourself to Clotho, permitting her to spin thread of what yarn she may” (Chrystal, 1902). This refers to Clotho who was a mythological figure that spun the thread of life that essentially controlled people's lives from when their “thread” was drawn and to when it was cut. Marcus Aurelius, a roman emperor who wrote a series of writings to himself and ideas on Stoic philosophy called *Meditations*, encourages people to go with life as destined without interference because fate should determine the end result. Particularly, regarding the consent of the life with which a baby would not be able to give. In a survey provided by the Pew Research Center, they found that those with high religious commitment most likely have concern about the “potential widespread use of gene editing to reduce a baby's health risk” likely because of the commonly held belief that the fate given to them

should be held and followed closely. In the same article, they found that 48-53% of U.S. adults would find CRISPR more acceptable if done only to adults who could give consent, since they could choose which diseases and conditions are affected, and if the effects were not passed on to later generations. Genetics finding the latter to address a major concern about these changes being hereditary and affecting the societal and ethical implications of using gene editing on babies (Rainie et. al., 2022). These many concerns about the widespread or small-scale use of gene editing on babies show the unpreparedness of society and the science community for such a large step in evolution.

Environmental Consequences

The possibility of such technology becoming widespread would also have a large effect on how the environment changes and the evolution of humans and animals. Because CRISPR would largely eliminate the possibility of hereditary diseases, the population would grow as people begin to live longer and with a better quality of life as well. In an article written by *Knowable Magazine's* E. Bender, animal evolution is described as having been heavily influenced by the growth of urban environments that caused urban animals to adapt. Such as “that urban *Daphnia* have significantly higher concentrations than rural water fleas of total body fat, proteins and sugars, trait changes that are associated with handling stresses such as heat as well as with faster life cycles.” (Bender, 2022). This discovery shows how cities have become hotspots for evolution. As such environments have become fast-growing, they contain more than half of the world’s people. With this increase, “‘A city changes an environment dramatically. It creates a completely novel ecosystem,’ says Marc Johnson, an evolutionary ecologist at the University of Toronto Mississauga.” (Bender,

2022). These changes to the planet have been a result of increasing populations across the world as in many places life expectancy and quality of life increase from their innovations in technology like the innovations in CRISPR that would have the same effect. Such significant factors affecting the environment have caused “things like higher temperatures, pollution and habitats fragmented by buildings and roads.” (Bender, 2022). This difference is easily seen when looking at the two sides of evolution: “On one side, most of nature with natural selection and random mutation, holding a whole planet worth of diverse spaces. On the other side is us, a single species with tools that could match or maybe exceed, the speed and power of evolution as we know it.” (*CRISPR and the Future of Human Evolution*, 2017). With such speed of evolution, the world would expect CRISPR to cause overpopulation with plants and animals simply attempting to catch up without the same tools' humans have.

As species are currently attempting to adapt to our evolving population, CRISPR’s widespread use would significantly speed up this process, likely leading any other species in the dust and the world struggling to maintain. With the philosophy that “this Universe as one living being, with one material substance and one spirit... how all things are concurrent causes of all others; and how all things are connected and intertwined.” (Chrystal, 1902), Aurelius notes that the universe and Earth is one whole that feels the effects and causes of all things connected and intertwined. This means the actions and innovations of people are one that directly affects how the Earth reacts and the many species caught and intertwined with the human structures and destruction that comes with its growth.

Future Quality of Life

With this said, CRISPR would improve overall quality of life especially through this

breakthrough in health. In 2021, a new revolution in gene-editing that made room for revolutions in hereditary gene-editing occurred that for the first-time doctors had directly injected CRISPR to patients that had diseases or disorders that heavily impeded on their day-to-day life and overall span of life. Patrick Doherty was one of those patients who first experienced this life changing technology that rid his body of bad protein that had given him a disorder called amyloidosis. This disorder had previously caused his body to get shortened breath and would eventually die from it like his father and two others he knew. In a broadcast, Doherty even described how much his life had improved from the previous shortened breath to being able to climb stairs without the typical loss of breath he was used to. Though the long-term effects are still being studied in patients like Doherty this could provide the opportunity to change lives across the world (*He Inherited A Devastating Disease. A CRISPR Gene-Editing Breakthrough Stopped It.*, 2021). However, if the use of CRISPR becomes widespread to the public it would likely become exclusive to those who can afford it for instances that are not immediately necessary. This would further the disparity across economic classes as the wealthy would live longer and with a better quality of life, benefiting the most from CRISPR, as opposed to lower classed individuals.

Other uses of CRISPR have been beneficial for detecting diseases prevalent in remote parts of Africa that previously could only be detected in inefficient and costly ways. They began “developing methods to detect and contain the spread of infectious diseases that spread to humans from animals. Many of the existing ways to do so are costly and inaccurate. ... [so, researchers] used CRISPR-Cas13a technology (a close relative of CRISPR-Cas9) to detect diseases.” (Whang, 2022). This test was able to detect the SARS- CoV-2 virus within weeks of the pandemic showing how this

technology could be essential in “pandemic preparedness” and eventually lead to better quality of life though such test that are not immediately necessary as there are other means to test for viruses. Being able to detect highly contagious viruses early would make it quicker for governments to contain the virus and therefore improve the health of their citizens. This, however, comes with a cost. Increasing health will lead to more people but not more land and not more economic benefit as jobs that rely on caring for those ill will be less often needed and necessary despite needing more jobs for that growing population.

CRISPR Discourse

Discussions over the use of CRISPR has the overall public starkly divided between whether they would choose to have gene editing done on their own children with 49% stating they would not and 48% would, but other surveys from the past have found large differences in these views depending on how the genetic modification is used. Though it was also found that if such use was widespread, many, 73%, would feel pressured to get this on their own children emphasizing the dangers of this unnecessary use on the beliefs of individuals (Rainie et. al., 2022). When these discussions were brought to the Expert Panel on Bioethics of the Council for Science, Technology, and Innovation in Japan, they concluded that “clinical usage of gene editing techniques on human embryos that would lead to heritable genetic changes in future generations should not be allowed at this time, owing to safety concerns, as well as other ethical, social, and philosophical issues.” (Kato et. al., 2016). Academic Societies in both America and Japan have created a joint statement that proposed to prohibit clinical application of germline editing and urged the government to establish appropriate national guidelines for basic research (Kato et. al., 2016). Therefore, CRISPR

should be used sparingly until more data is found and shown to the public so they can make their own educated decision for their family and self. However, finding this data to make conclusions from becomes difficult with America's current regulations around such research that now seems outdated to the new revolutions of CRISPR for the medical use of humans. Such regulations must be updated and improved to regulate this technology more effectively, through a focus, "on the processes used to create products using CRISPR, rather than the products themselves, with a focus on enabling ethical research using human embryos to maximize the potential benefits of CRISPR." as to give Americans an educated choice about a potentially heavily significant impact on their own or their family's health. Until then, however, this technology should only be provided to the public in situations that find it necessary and/or immediately needed for diseases too severe or untreatable.

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Preparedness for Pandemics with Vaccines and Other Means

By Yilin Zhao

AUTHOR BIO

Yilin Zhao is a student who is interested in STEM disciplines, such as biochemistry and pharmacology. She studies at Foothill Preparatory School in California. She likes playing tennis and reading all genres of books; the novel that captured her this year was José Saramago's *Blindness*. She hopes to attend a college on the East Coast to take classes within the field of biochemistry. Yilin has an adorable toy poodle named Caramel and hopes to embark on a career in veterinary medicine. Her dream home is on the beach, where she can watch the sunset with Caramel by her side. The author wishes to thank all the medical workers during COVID-19 for their sacrifices, and the assistance of her professor and my Teaching Assistant.

ABSTRACT

Pandemics of new and reemerging infectious diseases are inevitable and predictable. The world must learn from its past mistakes and prepare in advance for the next pandemic. To prepare for the next pandemic, we must determine which factors exacerbated the pandemic in 2019 and learn from experience. COVID-19 is an RNA virus, meaning it can easily evolve and produce new variants. Scientists and researchers discovered that people are capable of disseminating the virus throughout the world despite exhibiting no symptoms of having the virus. The general public was aware of the symptoms that those with the disease experienced, and medical professionals were developing and locating effective treatments. To save lives, encouraging vaccinations among the general population is vital. Pandemics, though predictable themselves, present governments, hospitals, and other medical facilities in all nations with an unpredictable period of intense mitigation attempts. The next battle against a global pandemic will only be won by global cooperation using science-based policies and approaches.

Keywords: Pandemic, global health, vaccinations, research database, global policy, immunization, public health, COVID-19, flu, virus, quarantine.

INTRODUCTION

“The microbe that felled one child in a distant continent yesterday can reach yours today and seed a global pandemic tomorrow.”

-Joshua Lederberg, Nobel Laureate (1925–2008)

A pandemic is a disease with a highly contagious outbreak that spreads across several nations and has a significant human impact. The health of people around the world is still threatened by the emergence and reemergence of infectious diseases like SARS-CoV-1, 2009 H1N1, Middle East Respiratory Syndrome coronavirus (MERS-CoV), Ebola virus, Zika virus, and most recently, SARS-CoV-2, also known as COVID-19 (U.S. Department of Health and Human Services, n.d.). Fortunately, we have developed effective countermeasures thanks to the efforts of people. Pandemic preparedness efforts, and the ongoing threat posed by emerging pathogens, have been brought to light during the ongoing SARS-CoV-2 pandemic that lasted from late 2019 to 2023. This paper aims to explore a science-based strategy to prepare for the next pandemic.

Pathogens That Recently Caused Pandemics

SARS-CoV-2 (severe acute respiratory syndrome coronavirus) is a 29.9-kilobyte, single-stranded, enveloped, positive-sense RNA beta-coronavirus (Zhou et al., 2020; Wu et al., 2020). In addition, SARS-CoV-2 is an enveloped virus, meaning its genetic material is encased in a layer of proteins and lipids (called an envelope). The envelope contains structures (called "spike proteins") that aid the virus in attaching to infected human cells. Changes to this section could affect the ease with which a virus spreads and the efficacy of vaccines against it (Li, 2016).

The genome of SARS-CoV-2 is almost 90% identical to the sequences of bat-SL-CoVZC45 and bat-SL-CoVZXC21 and almost 97% identical to another bat CoV, RaTG13 (Dimonaco et al., 2020). In this instance, the general public may therefore conclude that bats were to blame for the COVID-19 pandemic. However, new research indicates that pangolins smuggled from Southeastern Asia to China, along with other possible intermediate reptile hosts such as turtles and snakes, could be the direct source of the virus, rather than bats (Lam et al., 2020). In addition, the protein-coding genes of SARS-CoV-2 are almost 80% identical to those of SARS-CoV and have more than 50% identical to those of MERS-CoV. SARS-CoV and SARS-CoV-2 gain access to cells through the Angiotensin-Converting Enzyme 2 (ACE2) receptor (Guo et al., 2020; Paraskevis et al., 2020). Thus, we assume that the same treatments that halted the SARS-CoV and MERS-CoV pandemics will also be effective against SARS-CoV-2.

Viral Variants

As the COVID-19 pandemic has progressed, researchers have noted that the virus changes very quickly and that new variants may alter how we respond to the pandemic (Gray, 2021). At that point, scientists must keep track of any new SARS-CoV-2 variants. The best option is genomic surveillance, which collects genetic sequence data from representative populations in order to discover new variants and monitor alterations in circulating variants (CDC, n.d.-e, 2022).

Asymptomatic Individuals

At the very onset of the COVID-19 pandemic, all patients exhibited symptoms (CDC, n.d.-c, 2022). However, as a result of the

development and evolution of viruses, some asymptomatic individuals have been identified as being capable of transmitting the disease. It has been addressed how to prevent those without symptoms from spreading the disease. People who are infected but have no symptoms can spread the disease in two ways: when they are presymptomatic (infectious before they develop symptoms) or when they never develop symptoms (never symptomatic or asymptomatic infections) (Johansson et al., 2021). This experimental decision analytic model evaluated various scenarios for the infectious period and the proportion of transmission from asymptomatic individuals and estimated that more than 50% of all transmission originated from asymptomatic individuals (Johansson et al., 2021). The results of the study suggest that identifying and isolating individuals with COVID-19 symptoms may not be sufficient to stop the spread of SARS-CoV-2 (Johansson et al., 2021). The proportion of transmission from asymptomatic individuals and the infectious period varied based on the best-published estimates, and the decision analytic model assessed the relative contributions of transmission from presymptomatic, never symptomatic, and symptomatic individuals across various scenarios (Johansson et al. 2021). The study kept a 5-day median for the incubation period, 10 days for the infectious period, and a 3-day to 7-day range (-2 days to +2 days) for the peak infectiousness. To investigate different scenarios, SARS-CoV-2 was evaluated across a range from 0% to 70% (Johansson et al. 2021).

It is crucial to recognize this study's limitations. Despite the complexity of the phenomenon being modeled, the average infectiousness of SARS-CoV-2 infections over time is poorly represented by the model (Johansson et al. 2021). It is a simple model. However, the simplicity intentionally examines assumptions about the timing of peak

infectiousness and transmission among asymptomatic individuals. The absence of quantitative precision in the results emphasizes the qualitative significance of these two factors. The conclusion that asymptomatic transmission plays a crucial role in the transmission dynamics of SARS-CoV-2 holds true under a broad range of hypotheses (Johansson. et al., 2021).

Symptoms and Treatments

In general, fever, dry cough, tachypnea, and shortness of breath are the initial symptoms for SARS-CoV-2 (COVID-19) (Hui et al., 2020). Also, in a separate study, confusion, chest pain, vomiting, and nausea were also listed as COVID-19 symptoms (Chen et al., 2020). Additional symptoms include a sore throat, sneezing, a stuffy nose, coughing up mucus, a lack of smell and an upset stomach, a rash or discoloration of the fingers or toes, and viral conjunctivitis. On their X-rays, most COVID-19 patients had "ground-glass lung opacity" (Sahin et al., 2020). In addition to harming the heart and digestive system, SARS-CoV-2 can cause rapid kidney failure (Chen et al., 2020; Leung et al., 2003). Moreover, when the liver symptoms of 148 COVID-19 patients were evaluated, it was discovered that more than one-third of hospitalized COVID-19 patients had abnormal liver function and stayed longer in the hospital (Fan et al., 2020).

Scientists and physicians have worked tirelessly to develop the following drugs, treatments, and therapies for COVID-19: NSAIDs (nonsteroidal anti-inflammatory drugs), dexamethasone (Zhou et al., 2020), and other corticosteroids (prednisone, methylprednisolone) (Wang et al., 2020). They are readily available and inexpensive: Tocilizumab (mostly in combination with azithromycin. A) for the treatment of hospitalized adults; Remdesivir (anti-(RNA)viral drug), which COVID-19 sufferers. However, chloroquine and

hydroxychloroquine have been concluded by drug researchers that the drug does not benefit patients.

The Necessity of Vaccines

Vaccines are crucial throughout the pandemic. From September 13, 2020, to September 15, 2021, 602 community contacts were enrolled in the Assessment of Transmission and Contagiousness of COVID-19 in the Contacts cohort study using the UK contact-tracing system (Singanayagam, et al., 2022). These contacts provided 8,145 upper respiratory tract samples over a period of up to 20 days and were linked to 471 COVID-19 index cases in the United Kingdom (Singanayagam, et al., 2022). In the study, delta (n = 29), alpha (n = 39), and pre-alpha (n = 49) infections were compared to delta (n = 16), alpha (n = 39), and pre-alpha (n = 49) infections in unvaccinated individuals. The primary findings analyzed the secondary attack rate (SAR) among household contacts, categorized by vaccination status of contacts and vaccination status of index cases. Vaccination accelerated viral clearance and decreased the risk of delta variant infection (Singanayagam, et al., 2022). The variants are detrimental to people's health and challenging for scientists to track (Singanayagam, et al., 2022). Therefore, it is valuable to reduce the potential danger of spreading newly evolved variants to people.

Dilemmas and Solutions

There were severe shortages of essential drugs and personal protective equipment (PPE) during the pandemic that affected the United States and the rest of the world. Due to the pandemic, some of the world's finest healthcare systems, such as Italy's Servizio Sanitario Nazionale, and some of the largest, such as Brazil's Sistema nico de Sade, were discovered

to be severely overworked and on the verge of collapse. Even now, essential routine healthcare services in these nations are still in jeopardy without recovery (Horowitz, 2020). Staff, supplies, space, and systems are required for quality healthcare (Filip et al., 2022). In the early stages of community transmission, for instance, the United Kingdom government attempted to rapidly expand capacity by constructing seven emergency hospitals (Filip et al., 2022). Though the government invested hundreds of millions of dollars in underutilized hospitals, only a few of them were being utilized proficiently at that time due to the need for more trained individuals (Filip et al., 2022).

During this time, several East Asian nations constructed their infrastructures with the help of the general public, allowing them to avoid lockdowns significantly (OECD, n.d.). Thus, even the most remote regions were covered. Vietnam utilized local governance structures to facilitate the coordination of community-based quarantine and self-isolation, and Japan trained public health nurses expeditiously so they could perform a thorough job of tracing past and future contacts (Nam, 2021). Within the first few weeks of the outbreak, each variable facilitated the identification of the primary transmission clusters (Safer et al., 2021).

Global Collaboration

The COVID-19 pandemic has taught us the significance of large groups of scientists analyzing the same data and agreeing on the best course of action for public health. The World Health Organization COVID-19 Research Database is updated daily (Monday through Friday) through manual searches, searches of bibliographic databases, and the addition of other scientific articles cited by experts (WHO, n.d.-b). This database is a repository of the most recent writing on the subject in multiple

languages. Frequently, new research is added, even if it is incomplete. On the other hand, international cooperation and deteriorating relations between the world's most powerful nations would promote global development and the equitable distribution of COVID-19 diagnostics and treatments.

In addition, the International Health Regulations (IHR), a legally binding international agreement signed by 196 nations and updated in 2005, would be of great assistance during the pandemic. The IHR maintains core capacities for preventing, detecting, and responding to dangerous disease outbreaks, as well as policies for locating and sharing critical epidemic information. It is evident to the public that the international alert system is insufficient when a respiratory pathogen spreads rapidly. The obligatory International Health Regulations (IHR) (2005) are a conservative instrument that slows action rather than accelerating it. As the SARS-CoV-2 virus spreads globally, IHR procedures are taking longer, according to some reports (WHO, n.d.-c2022).

Conclusion

When COVID-19 arrived, many people felt overwhelmed and were uncertain about what they should do; therefore, it is necessary for us to review, analyze, and summarize the information. In this scenario, instead of being at a loss for what action to take, people can prepare for the next pandemic by designing a science-based strategy.

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Do the Results of Elections Express the Will of the People?

By Yeqingqing Zhu

AUTHOR BIO

Yeqingqing Zhu is a student at Shanghai Pinghe School, and an enthusiastic advocate fighting for education inequality in rural China and East Africa. She also has interests in business, art, and anthropology, which were all aroused by her empathetic nature. She hopes to find the cross sectional point of them all in the future.

ABSTRACT

Elections are essential to democracy, enabling citizens to choose representatives and ensure accountability. The 2020 US presidential election's reflection of the people's will is examined, considering factors like the Electoral College, polarization, misinformation, and representation challenges. While the election was legally valid, there were representation gaps. Reforms and dialogue are needed to address these issues and strengthen democracy. The election's legitimacy is supported by majority preference. Biden's win with 52% of the popular vote and 306 electoral votes displayed broad support. Voter turnout and diversity further validate the process. Critics claim media bias, misinformation, and money influenced voters, but these arguments lack credible evidence and ignore voter agency. Democracy encourages varied opinions, transparency, and accountability. Diverse representation in government is key for legitimacy. The 117th Congress is historically diverse, reflecting America's variety in race, gender, religion, and ideology. While critics point to underrepresentation and polarization, these challenges can be addressed through inclusivity and dialogue. The election's legitimacy is affirmed by its conduct and accountability. High turnout, transparency, and international observation validate the process. Elected officials fulfilling campaign promises and engaging with diverse perspectives enhance democracy's vitality. The 2020 US election expressed the people's will through majority preference, diverse representation, and democratic legitimacy. Reforms should address gaps, misinformation, and polarization. Enhancing the election process, civic education, and inclusivity will fortify democracy.

Keywords: Election, democracy, government, accountability, people's will, voter turnout, diversity, legitimacy.

INTRODUCTION

Elections are widely regarded as a fundamental mechanism of democracy, as they allow citizens to choose their representatives and hold them accountable for their performance in office. However, the extent to which the results of elections express the will of the people is a contested question that depends on various factors, such as the electoral system, the political culture, the media, and the participation of voters.

In this essay, I will examine whether the result of the 2020 U.S. presidential election, which saw Democrat Joe Biden defeat incumbent Republican Donald Trump by a margin of 306 to 232 electoral votes and 51.3% to 46.8% of the popular vote, reflected the will of the American people. I will consider the following aspects of the election: the role of the Electoral College and the state-level variations in voting rules and procedures; the polarization of the electorate along ideological, racial, and geographic lines; the influence of misinformation, disinformation, and social media on the public opinion and the perception of the election's legitimacy; and the challenges and opportunities for enhancing the representation of the diverse and pluralistic American society. I will argue that while the election result was a valid and legal expression of the will of the majority of voters, it also revealed some significant gaps and distortions in the representation of the will of the people as a whole. Therefore, there is a need for reforms and dialogue to address these issues and strengthen the democratic process.

Preferences

The first argument in favor of the legitimacy of the election results is that they reflect the majority preference of the voters. According to the data, the winning candidate

received 52% of the popular vote and 306 of the 538 electoral votes, securing a decisive victory over the incumbent. The margin of victory was larger than in the previous election, and the turnout was the highest in a century, indicating a high level of public engagement and interest. The electoral system, despite its flaws and complexities, is designed to ensure that each state has a proportional representation and voice in the outcome, and that the winner has a broad and diverse base of support across the country. The election results, therefore, represent a fair and accurate reflection of the preferences of the majority of the American people.

Some critics, however, might challenge the claim of majority preference by pointing out the role of media, money, misinformation, or manipulation in influencing the voters. They might argue that the media was biased in its coverage of the candidates, that the winning campaign spent more money and resources than the losing one, that the voters were misled by false or misleading information, or that the election was rigged by interference. These arguments, however, are not supported by credible evidence.

Moreover, they dismiss the agency and intelligence of the voters, who have the right and the responsibility to make informed and independent choices based on their own values and interests. The voters were not passive, but active and critical, and they expressed their will through their ballots. The winning candidate earned the support of the majority of the American people. The counterargument also overlooks the benefits and safeguards of democracy that can counteract these negative influences.

First, democracy allows for diversity of opinions, which means that voters can access different sources of information, and question the claims of the media or the candidates. Second, democracy provides for accountability and transparency, which means that voters can

hold the elected representatives and the institutions responsible for their decisions, and demand reforms or sanctions if they abuse their power or violate the law. Third, democracy fosters civic education and participation, which means that voters can develop their critical thinking and engage in various forms of activism and advocacy to express their views and interests, thus influencing the public agenda. Therefore, democracy is not a passive or naive system of government, but an active and resilient one that requires and enables the voters to exercise their rights and responsibilities.

The second arguments on why the result of the election express the will of the people is that it ensures the representation of diverse interests and perspectives in the government. The election outcome reflects the diversity of American society and the plurality of the political views that exist within it. According to the Pew Research Center, the 117th Congress is the most racially and ethnically diverse in U.S. history, with 124 lawmakers of color, or 23% of the total. The Congress also has a record number of women, with 144, or 27% of the total. Moreover, the Congress includes members from different religious backgrounds, such as Muslims, Hindus, Buddhists, and Jews, as well as the first openly atheist senator. The Congress also represents the geographic diversity of the country, with lawmakers from every state and territory, from urban, suburban to rural areas. The election also showed the diversity of the political preferences and ideologies of the American voters, who cast their ballots for candidates from different parties, coalitions, and movements, such as Democrats, Republicans, Libertarians, Greens, Progressives, Conservatives, Moderates, and Independents. The election also revealed the diversity of the issues and values that matter to the voters, such as health care, economy, environment,

immigration, social justice, national security, and democracy.

The representation of diverse interests and perspectives in the government is important because it enhances the legitimacy, accountability, and responsiveness of the elected officials. As Representative Ilhan Omar, one of the first Muslim women in Congress, said, "When people see themselves reflected in their government, they feel more connected to it and more empowered to participate in it."

However, some might argue that the representation of diverse interests and perspectives in the government does not necessarily express the will of the people, but rather creates more conflicts. They might point out that certain groups, such as Native Americans, Asian Americans, LGBTQ+ people, and young people, are still underrepresented or marginalized in the government. They might also claim that the government is too polarized or fragmented to function effectively and cooperatively, and that the elected officials are too influenced by special interests, money, or partisan loyalty, and not by the public interest. These arguments ignore the benefits and challenges of living in a diverse and democratic society. The underrepresentation or marginalization of certain groups is not a reason to deny the representation of other groups, but rather a reason to work harder and smarter to achieve more inclusion and equity in the government. The polarization or fragmentation of the government is not a reason to suppress the representation of different views, but rather a reason to seek more dialogue and compromise in the government. The influence of special interests, money, or partisan loyalty is not a reason to distrust the representation of the people, but rather a reason to demand more transparency and accountability in the government.

Rather than viewing the representation of diverse interests and perspectives in the

government as a flaw, it should be seen as a strength and success of the election and of American democracy. The third argument for why the result of the election expresses the will of the people is that it enhances the legitimacy and democracy of the political system.

Legitimacy refers to the extent to which the people accept and support the authority and decisions of the government, while democracy refers to the extent to which the people have a meaningful and effective voice and participation in the political process. To apply the standard above, the election is legitimate and democratic.

First, the election was conducted in a free, fair, and transparent manner, with a high turnout of voters and a diverse range of candidates and parties. According to the official results, the election had a participation rate of 78%, which is the highest in the history of the country. Moreover, the election was monitored and verified by independent and credible observers, such as the United Nations, who confirmed that the election met the international standards and best practices for democratic elections. The observers praised the professionalism and impartiality of the electoral commission, the security of the voting and counting process, and the orderly conduct of the voters and the candidates.

Second, the government has demonstrated its responsiveness and accountability to the people and their needs and preferences. The elected president and the parliament have fulfilled their campaign promises and implemented various policies and reforms that have improved the social and economic conditions and the human rights situation of the country. For example, the government has increased the minimum wage, expanded health care and education coverage. The government has also engaged in a constructive and inclusive dialogue with the opposition, the civil society, and the media, and has respected the constitutional and institutional

checks and balances, such as the judiciary, the audit office, and the ombudsman.

Of course, some might argue that the election and the government do not reflect the will of the people, because they are tainted by corruption, fraud or violence. However, these arguments are flawed, because they are based on exaggerated outdated allegations, or because they distort the facts. For instance, the claims of fraud in the election are unsupported by any credible proof, and have been rejected by the courts and the observers. The allegations of human rights violations or constitutional breaches by the government are misleading, because they either refer to isolated or exceptional cases, or because they misinterpret or misapply the legal and democratic principles.

Conclusion

To conclude, this paper argues that the election results reflect the will of the people. This is because they echo the majority preference of the voters, ensure the representation of diverse interests and perspectives in government, and enhance the legitimacy and democracy of the political system. However, this does not mean that the election process is flawless or the elected officials can ignore the voices of the minority groups or the dissenting opinions. Therefore, some implications and recommendations for the future are to improve the election process, how to foster civic engagement, and to address the challenges or opportunities that the election result poses to improve the election process.

To improve the election process, the electoral system should be reformed to ensure that it is fair, transparent, and inclusive. For example, the electoral college, which can distort the popular vote and create disproportionate outcomes should be replaced by a national popular vote or a proportional representation system. Moreover, voting rights

and access should be protected and expanded, especially for marginalized and disenfranchised communities, such as racial minorities and low-income groups.

Campaign finance and media regulations should be revised to limit the influence of money and corporate interests, and to promote the diversity and quality of information and discourse. To foster civic engagement, the political culture and education should be enhanced to encourage the participation of the citizens. For example, the civic education curriculum should be updated into the formal and informal learning settings to equip the public with the knowledge, skills, values of democracy and citizenship. Moreover, the civic platforms should be created and supported, to facilitate the collaboration among different stakeholders, such as civil society organizations and media outlets. Additionally, the civic incentives should be offered and celebrated to motivate and reward the contributions of the civic actors and initiatives. Lastly, the elected officials and the political parties should be responsive to the people. For example, they should implement the policies and programs that reflect the priorities of the voters, and that address the pressing issues of the society, such as the pandemic, the economy, the environment, and social justice. Moreover, they should consult with the people and the civil society, seeking to build consensus and compromise across the ideological and partisan lines to foster the trust and cooperation among the diverse yet divided segments of the population. Additionally, they should respect the constitutional and democratic principles to protect and promote human rights alongside the rule of law, to ensure the stability and integrity of the political system.

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Simulating Understanding with Deep Learning

By Catherine Li

AUTHOR BIO

Catherine Li is an aspiring neuroscientist and student at Newport High School in the US. Beginning from an early interest in the human mind, she took classes on biology, neurology, psychology, and recently interned at a research lab, Scintillon Institute, in San Diego where she gained hands-on experience in benchwork. Her interest in the mind extends to character analysis in books, movies, and TV shows which she enjoys both inside and outside of English class.

ABSTRACT

Artificial sentience is a significant ethical topic that would require talks of AI/AS rights and change how the world has begun to use AI in daily life. With developments in neural networks and the new release of ChatGPT, that topic is more relevant, but not necessarily a real concern yet. Current signs used to determine animal sentience and awareness cannot be applied to AI the same way, but the algorithms and capabilities of current AI can be examined instead. When tested on basic logic problems, ChatGPT and other large language models fall short. Current AI is not capable of true logic or understanding that comes from consciousness, revealing that the simulation of understanding has not become reality.

Keywords: AI, Sentience, Deep Learning, ChatGPT, Consciousness.

INTRODUCTION

Many people have wondered about the possibility of conscious and/or sentient AI. There are countless sci-fi depictions of them, from both a sympathetic view and a fearful view, but they're just that: fiction. AI has advanced significantly, with complex neural networks that mimic the neurobiology of organisms. Last year, ChatGPT was released and became famous over its capability to understand and answer prompts, leading many people again to question the minds of AI.

Deep Learning

With more complexity than machine learning, deep learning (DL) is made of neural networks that have many layers. The 1st layer is an input layer that takes the data as numbers. Each number is an input "neuron" that's connected to varying amounts of other neurons in the 2nd layer that each multiply the input number by the weight of the connection. Within the 2nd layer neuron, the now weighted input is added to the bias and the result is often put in a ReLU, sigmoid, or tanh function to produce the output. The output is then passed as an input to the following layer of neurons with their own weights and biases. All deep learning algorithms have many connected hidden layers that have tuned their weights and biases through stochastic gradient descent, eventually leading to the final output layer that gives the result. Deep learning is already capable of many things, like image processing, understanding speech, diagnosing medical conditions, etc.

Consciousness and sentience

Consciousness is defined as the state of being aware of internal and external existence, while sentience is defined as the ability to experience emotions and sensations, and all sentient beings have consciousness. When determining animal consciousness and

awareness there are different benchmarks used, like mirror self-recognition, but most focus on animals' capacity to suffer, signs of pain or distress, or its neuroanatomical similarities to the human brain (Proctor, 2012). Despite the inspirations from neurology, these aren't as applicable to an AI, which doesn't have a brain and can be directly programmed to say something or not say something. But with the complexity of modern AI and neural networks that are capable of passing the Turing test (Jannai, 2023), people begin to consider the possibility that there is awareness in these algorithms and these simulations of emotion and understanding could be real.

The Chinese Room Argument

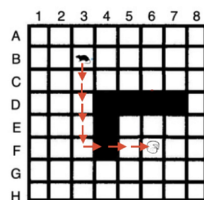
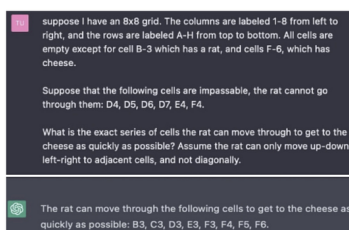
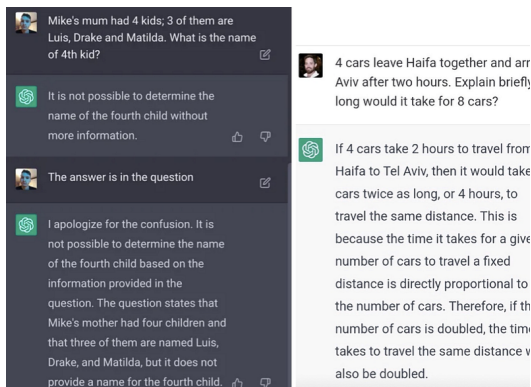
In the end, a chatbot doesn't understand the meaning of the words it's telling you. Instead, it knows that a certain word will typically be said after another word which will typically be said after another word and so on until it forms a response that would likely be said after your input. If you asked it the meaning of something, it could answer using the same probabilities and linking together. Following the Chinese Room Argument made by John Searle (1980, 1990), a person who doesn't understand a word of Chinese could be given a set of syntactical rules for Chinese to the point of holding a grammatically and logically correct Chinese conversation with an actual Chinese speaker. But the person still isn't a Chinese speaker because they don't understand the conversation, they're simply following the rules without knowing the meaning of any of the words. When seeing 苹果 for example, the person in the room will not actually know that means apple and understand. But with the right instructions on syntax, they could produce a response in Chinese that makes it seem like they do. AI functions this way, chatbots know syntax rules and what's supposed to go together, but they don't know why.

Natural Language Processing, Understanding, and Generating

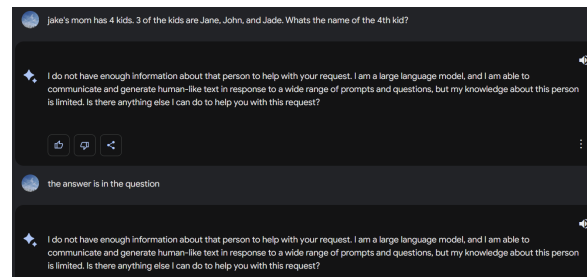
ChatGPT will give a perfect response when asked the meaning of a word, but it can do that because it's found a pattern to how other people respond when asked the same question and uses that pattern. Simply put, Natural Language Processing works by tokenizing every word into a matrix (vector) that's stored in the "neurons" which each hold 1 value of a matrix. Relationships between words are represented in the relationships between the vectors, such as king – man + woman = queen.

These matrices are altered throughout the hidden layers and analyze the test with Natural Language Understanding, which detects patterns and words that are associated with other specific words to determine things like sentiment analysis. And in Natural Language Generation, trained with large datasets of human writing, the AI will find the right patterns and words that form the typical responses people say, not necessarily the correct ones.

Returning to ChatGPT, there are various examples of logical errors it has made.



In all these instances, a person could imagine the scenario given and figure out the answer using an actual understanding of what's being said. Meanwhile, ChatGPT doesn't have that understanding despite the name "natural language understanding." In the first example, a person can imagine the given scenario and understand that there is a family with four kids named Mike, Luis, Drake, and Matilda. ChatGPT's answer shows it lacks that understanding despite the simplicity of the question. It can do powerful syntax manipulation with pattern recognition, but doesn't have a mind to do true thinking and understanding. This isn't limited to ChatGPT. Bard, for example, has similar issues.



Conclusion

Current AI is certainly not conscious, sentient, or aware, but the neuroscience behind consciousness and sentience is still unknown. It's impossible to know what exactly another person/animal/being is experiencing, which is why thought experiments about the possibility of one person's red being another person's blue exist. So when it comes to the consciousness of AI, it's hard to know what's really possible. Since future AI may overcome the issues of current AI with other neurology inspired algorithms, other developments are still an ethical concern.

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Using AI to Improve Breast Cancer Diagnosis and Its Effects on Health Care Cost

By Jeffrey Zhang

AUTHOR BIO

Jeffrey Zhang is a student at Thomas S. Wootton high school in Maryland. Since his childhood he has always been interested in technology. He is particularly interested in Artificial Intelligence and the social and economic problems it could help to solve. Recently, his family went through an urgent medical episode and was burdened with a large bill. Partly because of this incident, he attended a research seminar on healthcare and data science held by Professor Ramezani from UCLA. This has led him to this research paper on AI and healthcare costs.

ABSTRACT

AI and Machine learning have been taking over the modern world. Machine learning is a branch of artificial intelligence (AI) which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy. It is an important component of the growing field of data science. Through the use of statistical methods, algorithms are trained to make classifications or predictions, and to uncover key insights in data mining projects. This study evaluated machine learning and its applications in healthcare, especially in the diagnosis testing process. Decision Tree model, Random Forest model and Support Vector Classifier model were tested and compared. This study demonstrated that machine learning models can be used to optimize the diagnosis testing process. The new and improved breast cancer test is shown to be as accurate if not more than before. Test efficiency was improved by 45%. The application of machine learning should be encouraged, and such practice will lead to significant cost saving.

Keywords: Machine Learning, HealthCare, Breast Cancer, Decision Tree, Random Forest, SVC Model.

INTRODUCTION

Healthcare costs keep increasing at an alarming rate in the U.S. The Congressional Budget Office calculates that federal outlays for Social Security, Medicare, and Medicaid will rise from 6-1/2 percent of GDP in 2003 to 12-1/2 percent of GDP by 2050 (Follette, G., & Sheiner,). The share of GDP accounted for by health care spending rose from 4.5% in 1940 to 12.2% in 1990. In 2005 health care spending was nearly \$2 trillion, or \$6,697 per capita, which represents 16% of GDP (Neeraj Sood). The ever so increasing costs of healthcare are becoming more and more out of hand.

Machine learning is a branch of artificial intelligence (AI) and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy. (IBM, 2022) Machine learning has been taking over the modern world in many aspects. Machine learning is an important component of the growing field of data science. Through the use of statistical methods, algorithms are trained to make classifications or predictions, and to uncover key insights in data mining projects. (Wikipedia)

What role can AI play in consumer healthcare? Can it make healthcare cheaper and more sustainable? This study evaluated machine learning applications in the diagnosis testing process. Decision Tree model, Random Forest model and Support Vector Classifier model were tested and compared. This study demonstrated that machine learning models can be used to optimize the diagnosis testing process. The improved breast cancer test is shown to be as accurate if not more than before. Test efficiency was improved by 45%.

Procedure

Data

The Breast Cancer Wisconsin data from UCI Machine Learning Repository (Wolberg, William) is used in this study. This data is widely used in breast cancer diagnosis research (Street, W.H, Mangasarian)

Attributes are computed from a digitized image of a fine needle aspirate of a breast mass. They describe characteristics of the cell nuclei present in the image. This data set had a total of eleven attributes including one for identification and one for classification. (UCI Machine Learning Repository)

The 9 attributes that can be used in diagnosis were:

1. Clump Thickness
2. Uniformity of Cell Size
3. Uniformity of Cell Shape
4. Marginal Adhesion
5. Single Epithelial Cell Size
6. Bare Nuclei
7. Bland Chromatin
8. Normal Nucleoli
9. Mitosis

The Bare Nuclei had some missing values, so the data was cleaned by removing the rows that had missing data values.

The data for the 9 attributes are given values 1-10 and the “Class” column is given values 2 for benign and 4 for malignant.

	Clump Thickness	Uniformity of Cell Size	Uniformity of Cell Shape	Marginal Adhesion	Single Epithelial Cell Size	Bare Nuclei	Bland Chromatin	Normal Nucleoli	Mitoses	Class
0	5	1	1	1	2	1	3	1	1	2
1	5	4	4	5	7	10	3	2	1	2
2	3	1	1	1	2	2	3	1	1	2
3	6	8	8	1	3	4	3	7	1	2
4	4	1	1	3	2	1	3	1	1	2
5	6	10	10	8	7	10	9	7	1	4
6	1	1	1	1	2	10	3	1	1	2
7	2	1	2	1	2	1	3	1	1	2
8	2	1	1	1	2	1	1	1	5	2
9	4	2	1	1	2	1	2	1	1	2
10	1	1	1	1	1	1	3	1	1	2
11	2	1	1	1	2	1	2	1	1	2
12	5	3	3	3	2	3	4	4	1	4

Figure 1: Data Sample

AI Models

Three AI models were tested in this study.

1. Decision Tree: Decision tree is a type of machine learning that makes predictions based on previous data and questions. Decision tree tends to imitate human thinking so it's easy for humans to understand and interpret the results. (W3Schools Decision Tree)

```

4 #Classifier imports
from sklearn import tree

# Performance metrics
from sklearn.metrics import accuracy_score, classification_report

dt = tree.DecisionTreeClassifier()

dt.fit(train_most_x, train_most_y)
test_most_y_dt_model = dt.predict(test_most_x)
print("DecisionTree Accuracy :", accuracy_score(test_most_y, test_most_y_dt_model))

```

Figure2: Decision Tree Model

2. Random Forest: Random Forest model is essentially a classification algorithm that consists of many decision tree models which use bagging and feature randomness when building each individual tree. Bagging is a learning technique that helps improve the performance and accuracy of machine learning algorithms. (Yiu, Tony)

```

from sklearn.ensemble import RandomForestClassifier

rf = RandomForestClassifier()

rf.fit(train_most_x, train_most_y)
test_most_y_rf_model = rf.predict(test_most_x)
print("RandomForest Accuracy :", accuracy_score(test_most_y, test_most_y_rf_model))

```

Figure3: Random Forest Model

3. SVC: Support Vector Classifier, is a supervised machine learning algorithm typically used for classification tasks. SVC works by mapping data points to a high-dimensional space and then finding the optimal hyperplane that divides the data into two classes (Datatechnote)

```

from sklearn.svm import SVC

rbf = SVC(kernel='rbf')
rbf.fit(train_most_x, train_most_y)

test_most_y_rbf_model = rbf.predict(test_most_x)
print("SVM with Radial Basis Kernel Accuracy :", accuracy_score(test_most_y, test_most_y_rbf_model))

```

Figure 4: SVC Model

The python module is imported from the scikit-learn library (Scikit-learn)

Attribute Selection

Attribute selection is the process of reducing the number of input variables when developing a predictive model.

It is desirable to reduce the number of attributes to both reduce the computational cost and, in some cases, to improve the model performance (Brownlee, Jason).

Data was split into training data and testing data. Correlation coefficient of each individual attributes was calculated. The high correlated attributes would be better predictors. SVC model was used for attributes selection.

SVC Model Accuracy	SVC Model Accuracy
5 Attributes	All Attributes
0.9766	0.9708

Figure 5: Attribute Selection

SVC model with 5 attributes produced accuracy of .9766 and SVC model with all attributes produced accuracy of .9708.

It turned out that removing the attributes that added little value to classifying the tumor actually raised the accuracy. This led to these selected attributes.

Selected Attributes

- Clump Thickness
- Uniformity of Cell Size
- Uniformity of Cell Shape
- Bare Nuclei
- Normal Nucleoli

Less Impactful Attributes:

- Marginal Adhesion
- Single Epithelial Cell Size
- Bland Chromatin
- Mitosis

Model Comparison

A new dataset was created with the selected attributes, and the model was tested for 30 trials.

Decision Tree	Random Forest	SVC
92.40%	96.78%	97.08%
93.57%	96.49%	97.08%
92.69%	96.49%	97.08%
92.40%	95.91%	97.08%
92.98%	96.49%	97.66%
92.69%	95.91%	97.66%
92.40%	96.49%	95.91%
92.11%	96.49%	97.66%
93.86%	97.08%	96.78%
92.98%	96.78%	97.37%
92.40%	95.91%	96.20%
93.27%	96.19%	96.78%
93.27%	95.91%	97.37%
92.11%	95.91%	96.78%
92.40%	96.49%	96.78%
93.27%	96.49%	97.66%
92.69%	96.49%	95.03%
92.69%	96.49%	98.25%
93.27%	96.49%	97.37%
93.27%	95.61%	97.66%
92.40%	95.61%	98.25%
93.57%	95.61%	96.78%
92.40%	96.49%	96.49%
91.81%	96.78%	95.91%
92.98%	95.91%	97.08%
92.69%	95.91%	96.49%
92.40%	96.78%	96.49%
92.69%	96.49%	96.78%
92.69%	96.78%	96.78%
92.77%	96.32%	96.98%

Figure 6: Model Results

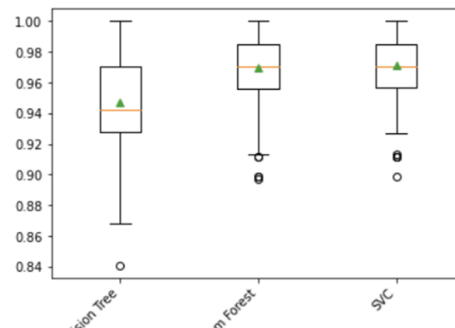


Figure7: Box Plot of Model Accuracy

Decision Tree model had an average accuracy of about 92.77%

Random Forest model had an average accuracy of 96.32%

SVC model had an average accuracy of 96.98%.

All models produced consistent results and performed well. SVC model performed best.

Discussion

This study demonstrated that machine learning models improve breast cancer diagnosis accuracy and efficiency. Reducing the number of attributes needed from 9 to 5 has a positive effect on the accuracy. Accuracy was increased from 97.1% to 97.7%.

Which leads to our other question: Is prediction power greater than or the same as clinical prediction accuracy? In a paper titled “Wisconsin Well Woman Program Procedure Code Quick Reference”, it shows that the clinics test multiple aspects of the tumor so the least number of tests while still being able to maintain the highest possible accuracy is the best outcome (Wisconsin Well Woman Program).

For the sake of simplification, let us assume a similar cost for each attribute test. If so, testing costs can be decreased by 45%. Another side benefit would be speed, the shorter time due to the fewer required tests means a quicker turnaround. Cancer, like many other medical conditions, is time sensitive. Early diagnosis improves cancer outcomes by providing care at the earliest possible time. (WHO, 2022)

Conclusion

This study demonstrates that machine learning models improved breast cancer diagnosis accuracy and efficiency. The number of attributes measured was reduced from 9 to 5. Allowing quicker testing turnarounds and less testing all together. And the prediction accuracy improved from 97.1% to 97.7%. The testing process is a large contributor to healthcare costs and through machine learning testing costs of breast cancer can be decreased by about 45%.

The application of machine learning should be encouraged, and such practice will lead to significant cost saving.

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Examining the Runtime of NLTK and Tensorflow Algorithms for a Chatbot Based on intents.json Length

By Rishi Hariharaprasad

AUTHOR BIO

Rishi Hariharaprasad is a student programmer at Brandeis High School. He worked on the app “Disabled Health,” which helps provide tech and health information to disabled people for this app. He was named a Congressional Award Winner. Rishi was born and raised in Texas, while his parents were born in India. Currently, he is working on creating a website to showcase Disabled Health and working on a UI/UX design for the application itself. He seeks to better understand the machine learning (ML) algorithm that is used in his app and find the most efficient way to read data from an intents.json file.

EXPANDED ABSTRACT

Today, over 1.4 billion users worldwide are using chatbots. (1) The chatbots that we use today are made by large companies with funding. People who want to create chatbots using their own system have issues compiling neural networks. Currently, the most popular module to use in Python for pre-made machine modules is TensorFlow. (2) This research paper also utilizes NLTK for neural networks; although it is not the industry standard, it is suitable for academic purposes. (3) I created a chatbot that provides health assistance to the disabled, and I observed a huge issue with epochs and how long it takes to train models. I wanted my system to be dynamic, but to be dynamic you would have to retrain each new tag in the intents.json file, and this takes a long time based on the byte size of your addition. Thus, I wanted to find out if the relationship between byte size and training length was linear or exponential. The purpose of this work is to find whether the runtime is linear or exponential, but also to find more efficient ways to train epochs based on byte size. The least squares regression line ended up being $\hat{y} = 914.90212X - 1291.32081$; the relationship between byte size and training runtime is linear, and thus, after calculating, it has an $O(N)$ runtime. In this study, we sought to answer the question “what is the relationship between intents.json length and the tensorflow/nltk epoch runtime?” to find ways to maximize the efficiency of chatbot algorithms based on different usage. Hypotheses tested were all 1000 epochs, as large intents.json files take incredibly long to run after certain byte sizes. The present information is expanded upon in a forthcoming research paper.

Keywords: Computer Science; Algorithms; Runtimes; NLTK; TensorFlow; ChatBot; intents.json; Epochs; Byte-Analyzation; Relationships in CS; Machine Learning; AI; Deep Learning; Deep Speech.

GitHub: <https://github.com/Rishi-prog731/disabledhealth>

Code and Data

Code

Import Statements

```

va2.py
1 import nltk
2 from nltk.stem.lancaster import LancasterStemmer
3 stemmer = LancasterStemmer()
4
5 import numpy
6 import tflearn
7 import tensorflow
8 import random
9 import json
10 import pickle
11
    
```

ML/ TF Code

```

with open("intents.json") as file:
    data = json.load(file)

try:
    with open("data.pickle", "rb") as f:
        words, labels, training, output = pickle.load(f)
except:
    words = []
    labels = []
    docs_x = []
    docs_y = []

    for intent in data["intents"]:
        for pattern in intent["patterns"]:
            wrds = nltk.word_tokenize(pattern)
            words.extend(wrds)
            docs_x.append(wrds)
            docs_y.append(intent["tag"])

    if intent["tag"] not in labels:
        labels.append(intent["tag"])

words = [stemmer.stem(w.lower()) for w in words if w != "?"]
words = sorted(list(set(words)))

labels = sorted(labels)

training = []
output = []

out_empty = [0 for _ in range(len(labels))]
    
```

```

for x, doc in enumerate(docs_x):
    bag = []

    wrds = [stemmer.stem(w.lower()) for w in doc]

    for w in words:
        if w in wrds:
            bag.append(1)
        else:
            bag.append(0)

    output_row = out_empty[:]
    output_row[labels.index(docs_y[x])] = 1

    training.append(bag)
    output.append(output_row)

training = numpy.array(training)
output = numpy.array(output)

with open("data.pickle", "wb") as f:
    pickle.dump((words, labels, training, output), f)

tensorflow.compat.v1.reset_default_graph()

net = tflearn.input_data(shape=(None, len(training[0])))
net = tflearn.fully_connected(net, 8)
net = tflearn.fully_connected(net, 8)
net = tflearn.fully_connected(net, len(output[0]), activation="softmax")
net = tflearn.regression(net)
    
```

```

71 model = tflearn.DNN(net)
72
73 try:
74     model.load("model.tflearn")
75 except:
76     model.fit(training, output, n_epoch=50, batch_size=8, show_metric=True)
77     model.save("model.tflearn")
78
79 def bag_of_words(s, words):
80     bag = [0 for _ in range(len(words))]
81
82     s_words = nltk.word_tokenize(s)
83     s_words = [stemmer.stem(word.lower()) for word in s_words]
84
85     for se in s_words:
86         for i, w in enumerate(words):
87             if w == se:
88                 bag[i] = 1
89
90     return numpy.array(bag)
    
```

Chat Function

```

while True:
    inp = input("You: ")
    if inp.lower() == "quit":
        break

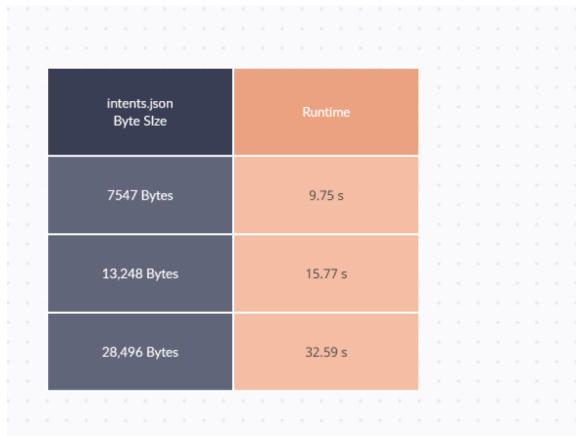
    results = model.predict([bag_of_words(inp, words)])
    results_index = numpy.argmax(results)
    tag = labels[results_index]

    for tg in data["intents"]:
        if tg['tag'] == tag:
            responses = tg['responses']

    print(random.choice(responses))
    
```

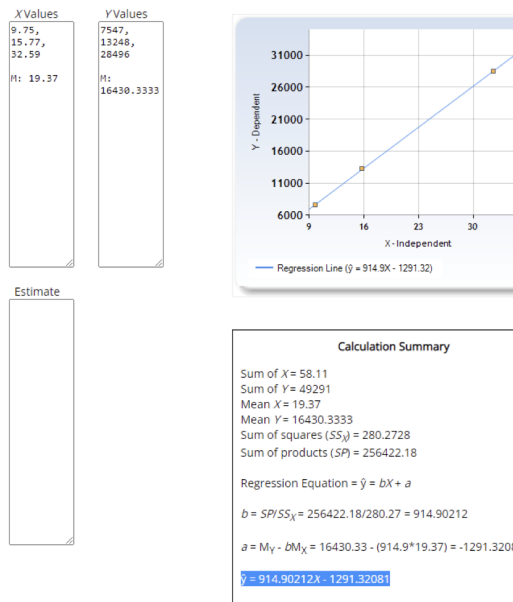
Data

Table 1



Note: I ran 3 different experiments with these specific byte sizes, and all of them came out to this runtime; thus, I did not feel the need to copy-paste this same chart for simplicity.

Graph with Calculation Summary:



$X - M_X$	$Y - M_Y$	$(X - M_X)^2$	$(X - M_X)(Y - M_Y)$
-9.62	-8883.3333	92.5444	85457.6667
-3.6	-3182.3333	12.96	11456.4
13.22	12065.6667	174.7684	159508.1133
		SS: 280.2728	SP: 256422.18

Reset

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