

University of Washington Bothell

# The CROW

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## LETTER FROM THE EDITORS

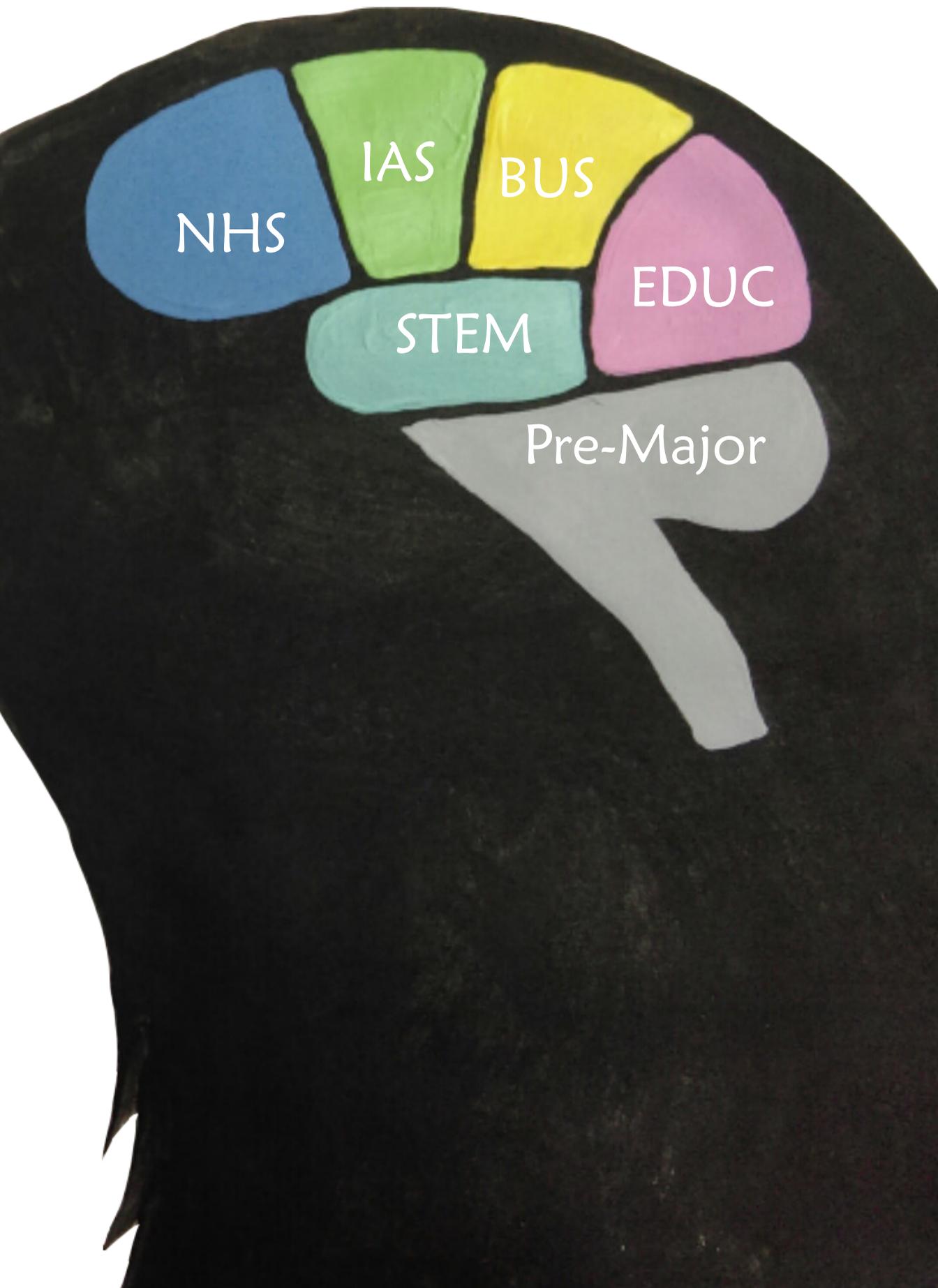
The Sixth Edition of *The CROW* was produced and published during the COVID-19 global pandemic. During this time, members of the UWB community have felt the pandemic affect every aspect of their lives, from the health and well-being of their communities to financial and job insecurities. The vast majority of teaching and learning was conducted remotely as well, which has brought new challenges to the student body. Simultaneously, this time has been marked by incidents of racial violence that have had profound impacts on the safety and security of communities of color nationwide. These are impacts we have felt here at UWB as well. We would like to take this time and hold space to acknowledge the hardships and the loss this past year has brought to so many in our communities.

With this Edition, *The CROW* continues to highlight the incredible dedication of students at the University of Washington Bothell as they conduct, analyze, and synthesize their own research investigations in topics ranging from science and technology, to the interdisciplinary arts, and everything in between. The act of conducting research is a highly-impactful learning practice that engages students outside of the classroom setting and allows them to think more critically about the topics they wish to discover. By taking the initiative to submit their work for review by a Board of their peers, the authors in this journal have taken steps towards becoming active contributors to the academic discourse of their particular field of study.

Due to the events that defined the 2020-21 academic year, we would like to extend special recognition and gratitude to our student writers. In addition to the personal risk each writer might experience in submitting their work for peer review, the students who worked with us this year did so through a unique set of global circumstances. We know submitting during this time must have been difficult, and we appreciate your patience and your effort. We are so excited we can share with you the 2021 Edition of *The CROW*!

Your friends on the Editorial Board,

Aaron, Alex, Christine, Dacia, Jordan, Karina, Mickena, Rachel, Rose, Salome, Shahrzad, and Sidra



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# POPULAR CHRISTIAN MUSIC IN TRUMP'S AMERICA

Jeanne Macbeth

*ABSTRACT: Since election day 2016, experts from various fields of study have weighed in on Donald J. Trump's political ascendancy and enduring support. A growing body of literature recognizes how the "Make America Great Again" movement has grown, in large part, out of a predominantly white, rural and suburban, Christian subculture (Pew Research Center, 2018). This subculture has been in steady decline for decades as the urban population increases (United States Environmental Protection Agency, 2015) and younger generations shift the nation towards ethnic, racial, and religious equity (Barna Group, 2020; Parker et al., 2019). In this context, my study examines popular Christian music as an important site of cultural production and consumption among a significant portion of Trump's base. After pinpointing the 12 most popular Christian songs during Trump's candidacy and through his pre-Covid-19 presidency, I conducted an inductive rhetorical analysis to identify the main messages, persons, and metaphors contained within the lyrics. I found that God is consistently presented as an ultimate, male authority who defies human reasoning and is worthy of loyalty in every circumstance. In parallel, every song portrays the believer as responding to a range of crises, consistently describing an external locus of control, adherence to individualism, and a high value for loyalty to God as a means of survival. I then utilized well-known New Testament passages and the Nicene Creed to construct qualitative codes for identifying the presence and/or absence of essential Christian themes. Roughly 75% of the songs relate to the power of God and the faith or hope of a believer who is mourning or poor in spirit. Most other Christian themes were mentioned once or not at all. By implication, the primary rhetorical purpose of this music is to affirm a personal theology consistent with authoritarian norms as a strategy for coping with perceived powerlessness.*

*Keywords: Christianity, Music, Trump, MAGA, Rhetorical Analysis*

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# THERMIONIC CONVERSION AS THE NEXT STEP IN THE MOVE TO RENEWABLE ENERGY

Nathan June

*ABSTRACT: As the world grapples with the consequences of climate change, our energy needs continue to grow and evolve. While the emission of electrons from the surface of a heated material has been a well-understood physical process for over seventy years, obstacles such as material work function and space charge prevented the development of sufficiently efficient converters. Despite these setbacks, theoretical efficiencies and other benefits, such as long operational lifespan and a lack of moving parts, have continued to drive technology interest. With recent advancements in material fabrication and device manufacturing, the thermionic converter is entering a new era. The development of semiconductors, nanotechnology, and combined emission mechanics makes necessary work functions achievable. Simultaneously, introducing interelectrode plasmas, microscale manufacturing, and interstitial gate electrodes is combating space charge. This paper provides a background on the physics of the phenomenon and summarizes the breakthroughs recently achieved in converter design and efficiency. We gradually shape a narrative that offers insight into potential applications and examines how these devices can contribute significantly to our push towards renewable energy and why their research and development must continue.*

## Introduction

As global energy demands increase, energy output requires high electron density, narrow electron-energy distributions, short emission times, and efficient excitation. In practice, these are all requirements that thermionic converters, which convert heat directly into usable energy, have struggled to realize (Trucchi, 2017). Nevertheless, thermionic energy converters offer us the most well-rounded approach to maximizing energy output as we reduce dependency on fossil fuels. Recent developments in material fabrication, semiconductors, nanotechnology, and a deeper understanding of their underlying physical process have breathed fresh life into the thermionic community (Go, 2017; Hogan, 2019). While there is much work to be done, thermionic energy converters (TECs) are rounding a corner, positioning them as key players across various industries.

This paper aims to provide a broad but succinct overview of the history of and process behind thermionics. As a means to advocate

for the continued development and application of thermionic converters, the paper begins by identifying obstacles that have prevented their widespread adoption, then moves to recent advancements and breakthroughs in the technology, and ends with possible future applications.

## History

It has not been uncommon for discoveries to be dismissed throughout history when their practical application comes into question. A British Parliament Committee suggested Edison's light bulb was "unworthy of the attention of practical or scientific men (Nguyen, 2016)." Einstein himself believed we would never directly detect gravitational waves due to their subatomic scales (*Gravitational Waves Detected 100 Years After Einstein's Prediction*, 2016).

Thermionic emission as a practical energy provider was no exception. Conceptually, the technology is not short of appealing characteristics. Theoretical efficiencies trend

upwards of 82% while the absence of moving parts prevents friction, keeps entropy low, and allows for long operational lifespans (Trucchi, 2017). Also, it generates no carbon emissions whatsoever.

While a handful of scientists observed it decades before the process was thoroughly understood, the theory of thermionic emission as we know it today began to develop over one hundred years ago. While studying the conductivity of gases in 1853, Henri Becquerel measured the current between hot and cold platinum wires. Though he failed to recognize the significance of thermal energy at the cathode, this was one of our first examples that something larger was at play (McCarthy, 2014). Twenty years later, Frederick Guthrie discovered that a negatively-charged iron sphere would lose charge if it were heated to extreme temperatures and placed in a vacuum, while a positively charged sphere would not (McCarthy, 2014; Mitchell, 2003). In 1883, Thomas Edison observed the potential of the process while attempting to improve his incandescent lamp. When he inserted a thin wire above the heated filament, he discovered a current flowing between the two metals (Gallet, 2001; Lienhard). Finally, with J.J. Thomson's work in 1897, the electron was recognized as a distinct particle, and the theory of thermionic emission was established (A Look Inside the Atom, 2007).

While this summarizes some of the initial discoveries that prompted a more thorough academic understanding of the phenomenon, it was not until the 1950s, fueled by competition with the Soviets during the Cold War, that American understanding translated into application. It is no coincidence that this technology's aggressive expansion coincides with both countries' nuclear and space-based ambitions (Go, 2017). A thermionic converter's real strength lies in producing energy from waste heat as a cogenerator. Moreover, its lack of moving parts and compact size made it an attractive option for space-based missions

(Morris, 1980; Trucchi, 2017). Sadly, despite significant contributions, challenges in material composition, device design, and overall public distrust of nuclear energy, led the United States to shift towards fossil fuel consumption in the 1970s. Our absence yielded credit for many advancements in materials and converter design to the U.S.S.R. (Go, 2017).

## Thermionic Emission

Thermionic emission is one of three primary methods of electron emission. All forms of emission refer to the ejection of electrons from a material. What distinguishes each type is the source of energy for the electrons. As the name suggests, thermionic emission involves thermal energy (McCarthy, 2014). When a material is heated sufficiently, the energy absorbed by its electrons allows them to escape, becoming unbounded (Abdul Khloid, 2016). A common metaphor to help visualize the process is the boiling off of electrons from the material's surface (Go, 2017). Different materials require different amounts of energy because of variances in atomic structure, purity, and surface morphology (Go, 2017; Abdul Khalid, 2016). The minimum amount of energy required to displace one electron from a material's surface to a point just beyond the surface is called the work function (Schlaf). The work function of most materials is on the scale of several electron volts (*Thermionic Energy Conversion*; Trucchi, 2017).

As Edison observed, this emission phenomenon, which he humbly dubbed "The Edison Effect," can produce a current between two electrodes capable of performing work (Foundation, 2013; Lienhard). The cathode, or emitter, is the heated material that emits electrons. The anode, or collector, is the material that collects the emitted electrons (Go, 2017). In its most elementary design, a thermionic converter has three components: the electrodes, connecting circuitry, and an electric load, such as a resistor (Abdul Khalid, 2016).

As electrons accumulate on the collector, a negative charge induces a voltage difference between the electrodes. Introducing a resistor then drives a current through the circuit (Abdul Khalid, 2016). This simplicity affords TECs low entropy; with no moving parts to create friction, they experience longer operational lifespans and run silently (Go, 2017), contributing to their ability to help optimize existing energy production.

## Traditional Device Design

As mentioned previously, meaningful progress in thermionics as an honest energy supplier did not arrive until the 1950s. It was then that George Hatsopoulos, from the Massachusetts Institute of Technology, developed two prominent converter designs. He designed each method to facilitate electron transport across space between electrodes called the interelectrode gap (Abdul Khalid, 2016). The first design was the vacuum TEC, or VTEC. It included a vacuum space between the electrodes to minimize atomic obstacles, allowing electrons to apply all their kinetic energy to crossing the gap instead of depleting it on costly elastic collisions (Bickerton, 2017; Abdul Khalid, 2016). The second design was called the vapor TEC, and involved filling the gap with a positively charged, ionized alkaline metal vapor, usually cesium, due to its low ionization energy (~3.9 eV) (Go, 2017). The single electrons in their outer shells make alkaline metals prime candidates for these applications (McCarthy, 2014). This positively charged vapor would help to “pull” electrons from the emitter, lowering its work function, though inherent downsides covered later abate this gain.

Typical working conditions expose emitters to extreme and repetitive heating and cooling cycles. Refractory metals are, therefore, frequently the material of choice (Foundation, 2013; Go, 2017; Katoh, 1997). While their definition remains relatively loose, all refractory metals exhibit hardness at room temperature and

are resistant to extreme heat, with most melting points occurring above 2,000 degrees Celsius. Five metals seem to make every list: Tungsten, Molybdenum, Niobium, Tantalum, and Rhenium (Rowe, 2003). That heat resistance also makes them renitent to creep, a mechanics of materials term referring to the long-term strain a material is subjected to by external forces (Foundation, 2013). These forces gradually compromise a material’s structural integrity until it ultimately fails. This additional trait prolongs operational lifespan and is another reason their use is appropriate in emitter design, providing a cost-efficient benefit in commercial, consumer, and government applications.

## Theory

The current density in thermionic conversion is governed by the Richardson-Dushman equation, although a more comprehensive understanding of the parameters involved is required.

$$J_{Thermionic} = AT^2 e^{\frac{-\phi}{k_B T}} \text{ (eq. 1)}$$

where T is the absolute temperature of the cathode, phi is the work function of the emitter material, k is Boltzman’s constant, and A is the effective Richardson constant, a parameter of the material (Go, 2017; McCarthy, 2014). The effective Richardson constant is itself further defined as,

$$A = \lambda A_0 \text{ (eq. 2)}$$

where lambda is a corrective parameter (1) that considers the material surface’s reflection coefficient and A<sub>0</sub> is a universal constant (Crowell, 1965). A<sub>0</sub> is defined as,

$$A_0 = \frac{4\pi m k^2 e}{h^3} = 120 \frac{A}{cm^2 K^2} \text{ (eq. 3)}$$

where  $m$  is the electronic mass,  $e$  is the electronic charge, and  $h$  is Planck's constant (van Dommelen, 2002).

We can immediately notice, to maximize current density, one must simultaneously strive for the lowest possible work function and highest possible temperature. While conceptually, this may appear straightforward, it is deceptively challenging. Among the several considerable hurdles plaguing the efficiency of TECs, one of the largest is the fact that several variables are essentially at odds with each other. For example, specific material may be optimal for an emitter because of its low thermal conductivity since we try to avoid heat loss. A material with high thermal conductivity may then be preferred for the collector to dissipate the heat collected via thermalization with electrons. However, both electrodes require high electrical conductivity, which could conflict with the emitter's thermal needs since the two conductivities are typically connected intrinsically (Go, 2017).

### Obstacles

To appreciate the competing nature of the variables involved, we will provide a more definitive explanation of each. In this section, we identify and discuss the various obstacles that have historically inhibited thermionic conversion efficiency.

### Work Function

A material's work function is often described as the energy gap between its Fermi level and the vacuum level (preventing an electron from being dislodged from its surface) or the minimum energy required to displace an electron from the surface of the material to a point just beyond the surface (Schlaf). However, this can vary slightly with semiconductors, which, in modern approaches, are frequently used. The work function is essentially a measure of how tightly a material clings to its electrons; the lower the work function, the less energy required (Chao, 2016). It is a complicated

parameter to determine precisely. In addition to being affected by the material's overall atomic structure, many external and internal factors contribute, such as purity of the material, bulk structure, surface morphology, and even thermal expansion (Kahn, 2016; Go, 2017; He, 2008).

As shown in the semiconductor energy diagram in figure 1, electron energy in an atom is quantized. The valence band maximum represents the highest occupied molecular orbital (HOMO), which is the highest energy obtained by an electron at zero degrees Kelvin. The conduction band minimum represents the lowest unoccupied molecular orbital (LUMO). The gap between the two bands is the additional energy an electron must obtain to move from the valence band to the conduction band. The electron must lose this amount of energy to move in the opposite direction. The Fermi level is the energy of the highest occupied orbital shell when measured at zero degrees Kelvin. It has been intentionally designed to reside within the energy gap to prohibit electron promotion into the conduction band, where it is free to

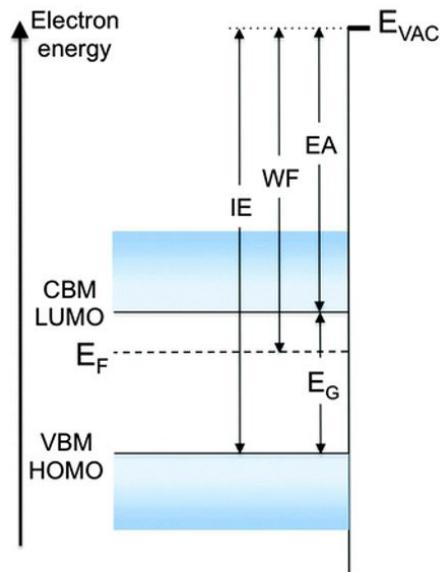


Figure 1: Energy diagram for the electrons of a semiconductor where  $E_F$  is the Fermi level,  $E_G$  is the energy gap between valence and conduction bands,  $E_A$  is the electron affinity of the material,  $W_F$  is its work function, and  $I_E$  is ionization energy (Kahn, 2016).

travel throughout the material unless it obtains sufficient energy (Kahn, 2016). This energy difference is called the Fermi energy. Since the conduction band energy level is still well below the vacuum potential's energy level, the work function is then the difference between the vacuum potential energy and the Fermi level (Schlaf). Once an electron has received this energy, it is ejected from the surface into the vacuum space between electrodes (Go, 2017).

Given that work function is a material property, it makes sense that a TEC emitter and collector could have differing work functions, which is preferably the case. The maximum voltage a TEC can produce is this difference, as described by

$$eV_{out} = (\varphi_e - \varphi_c) \text{ (eq. 4)}$$

while the overall power density is given by

$$P = JV_{out} = J\left(\frac{\varphi_e - \varphi_c}{e}\right) \text{ (eq. 5)}$$

Herein lies the first considerable complication (Go, 2017; Swifter, 2018). If eq. 1 requires the pursuit of the lowest possible value for an emitter's work function, then eq. 4 requires a work function even lower for the collector to maximize output voltage. Ideally, the collector's work function should be  $\sim 0.5$  eV, and practical application requires a difference of at least 1 eV (Go, 2017; Abdul Khalid, 2016). This condition presents a substantial challenge for materials.

### Space Charge

As electrons in the emitter are adequately excited, they use most of their kinetic energy to overcome the vacuum potential. This may or may not leave enough energy for them to cross the interelectrode gap (Schlaf; Khan,

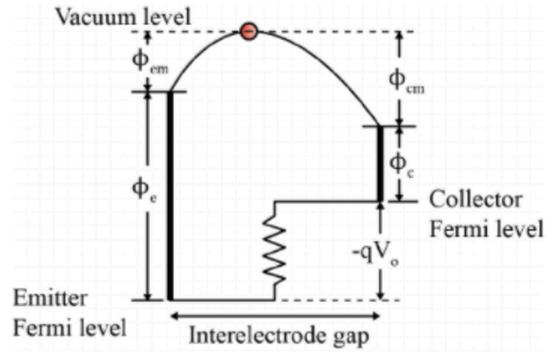


Figure 2: An energy diagram for a TEC showing the different Fermi levels between emitter and collector and comparing their different work function needs. The work functions denoted by  $\phi_m$  and  $\phi_c$  refer to the repulsive force of the space charge phenomenon. It illustrates the additional energy required for the surface to emit a particle when space charge is present (Abdul Khalid, 2016).

2016). This scenario can produce a cloud of electrons between the electrodes if the current density is high enough (Go, 2017). The negative charge of this cloud is capable of repelling new electrons attempting to cross the gap and, if it becomes strong enough, can prevent emission altogether (Swifter, 2018; Go, 2017; Trucchi, 2017). This effect is known as space charge, and it may be the single most considerable challenge in usable TECs as it can obliterate current between the cathode and anode (Go, 2017). As shown in figure 2, TEC energy diagrams often account for it with its own symbolic work function. Accounting for the resulting diminishing current requires consideration of the Child-Langmuir Law (Go, 2017).

$$J = J_{CL} \left( {}_2F_1\left(\frac{1}{4}, \frac{3}{4}, \frac{7}{4}, -\frac{eV_0}{2mc^2}\right) \right)^2 \text{ (eq. 6)}$$

where  ${}_2F_1$  is the hypergeometric function,  $e$  is the electron charge,  $V_0$  is the electrostatic potential,  $m$  is the electron mass,  $c$  is the speed of light, and

$$J_{CL} = \frac{4\epsilon_0}{9D^2} \sqrt{\frac{2e}{m}} V_0^{3/2} \text{ (eq. 7)}$$

where  $\epsilon_0$  is the permittivity constant of free space, and  $D$  is the distance between the electrodes (Gonzalez, 2017).

**Advances**

Nevertheless, as stated previously, there are reasons to remain optimistic. Modern approaches have provided a plethora of breakthroughs capable of addressing these obstacles and advancing thermionic technology.

**Materials Fabrication**

Much of the progress in thermionic design comes from emerging techniques in materials fabrication and blending of emission and absorption processes. These developments seek to address the obstacles mentioned above regarding material work function (Go, 2017).

Semiconductors are materials with conductivity between an insulator and a conductor and are vital to design more efficient TECs. The most effective way to describe the distinction between these three material types is

through energy diagrams, like the one visible in figure 3 (What are Semiconductors).

Energy diagrams depict the various orbital shells of atoms making up a material as horizontal bands. The highest energy level obtained by an electron when the atom is at zero degrees Kelvin marks the material’s Fermi level (Maestra, 2020). The band in which that electron resides is the valence band, the outermost occupied shell of the atom. There are energy bands above the valence band called conduction bands. These bands overlap just slightly in metal, as seen in figure 3c, with the Fermi level residing in the overlap (R. Nave). While no conduction occurs at absolute zero, this trait illustrates the minimal energy input required to run current through a conductor. Any electron that resides within the conduction band can flow with the current, and the overlap of the two bands ensures that a conductor lives up to its name.

However, if small amounts of a second element are added, such as phosphorus, which has five valence electrons, it would still share

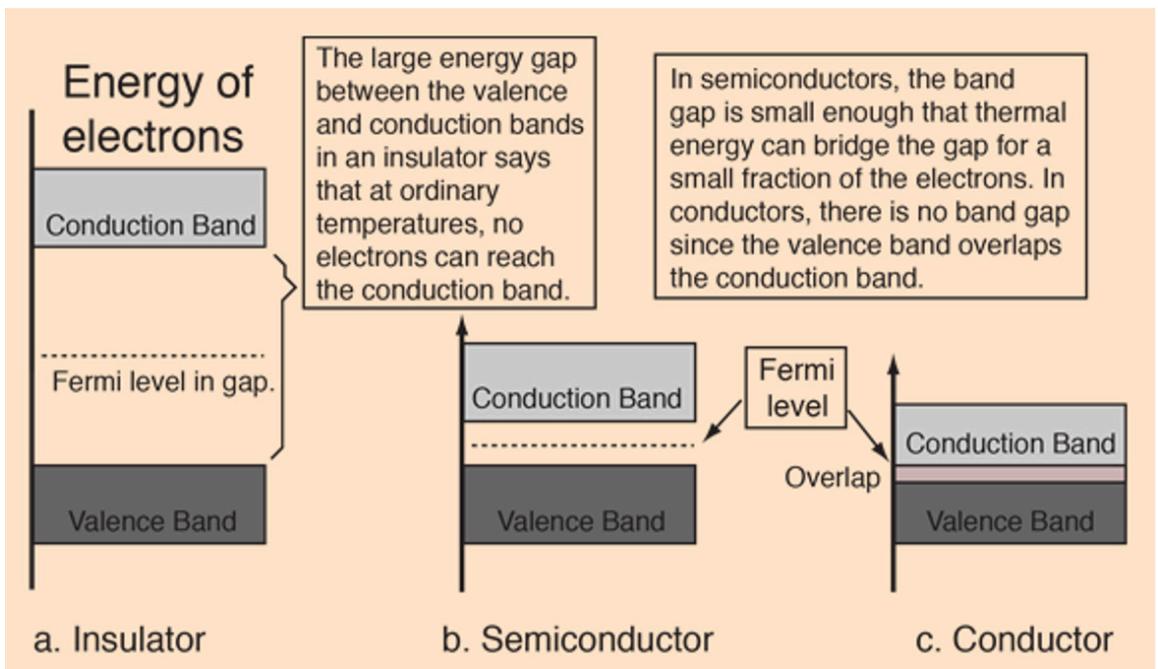


Figure 3: (a) shows the energy diagram of an insulator, characterized by a large energy gap between valence and conduction bands; (b) shows the energy diagram of a semiconductor with a moderate energy gap; (c) shows the energy diagram of a conductor with the valence and conduction bands overlapping (R. Nave)

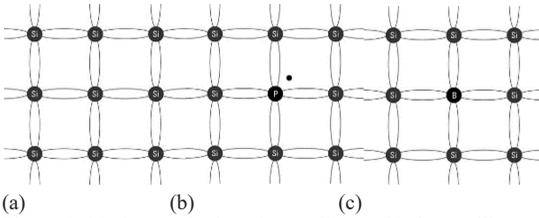


Figure 4: (a) shows a lattice of pure silicon; (b) shows silicon doped with phosphorus; (c) shows silicon doped with boron (Lowe)

two electrons and receive six. However, now it has an extra electron with no place to live (fig. 4b). This condition describes an n-type semiconductor and is possible because of doping, which involves adding impurities to a material. In this scenario, phosphorus is the dopant. In figure 4c, we see a silicon crystalline structure doped with Boron. Boron only has three electrons in its outermost shell. This results in an empty space in its valence shell. As an electron moves from one atom to fill it, it leaves behind a hole that also requires filling. In the presence of a potential, a definitive direction can be encouraged for this “fill a hole, leave a hole” pattern and current can be induced. This process describes what is known as a p-type semiconductor (Lowe).

Even minimally, doping a material has a strong influence on its Fermi level and, therefore, its conductivity (Go, 2017). Pairing semiconductors with doping is one of the most promising advancements in emitter design because it flaunts the possibility of retaining a material’s resistance to thermal conductivity while increasing its electrical conductivity. As the technique continues to advance, it may be possible to design a material exactly to whatever work function requirements are needed (Swifter, 2018). A recent study reported a work function of 1.7 eV for a semiconductor composed of barium oxide deposited on polycrystalline-silicon carbide substrate with a thin layer of tungsten for adhesion purposes. While further development is still required, it remained stable for several hours at temperatures between 900 and 1400 degrees Kelvin. Another study reported

a work function of 0.9 eV from phosphorus-doped polycrystalline diamond films on metallic substrates (Abdul Khaid, 2016).

As stated earlier, thermionic emission is just one of the three primary methods of electron emission. Secondary emission is another process, most frequently used in combination with photoemission. Although this is not a primary emission mechanism, it is possible to create a chain reaction through electron-multiplying stages. By accelerating emitted electrons towards a series of cascading dynodes, which emit several low-energy electrons for every high-energy electron that strikes them, it is possible to significantly increase electrons’ absolute yield value, increasing the current produced (Keidar, 2018). The chief drawback to this method is that since the photocathode’s sensitivity depends on the photon’s energy striking it, it is impossible to optimize emitter material for wide ranges in wavelength (Trucchi, 2017).

Unfortunately, since emitters play the most considerable role in the conversion process, much of the existing research has been dedicated

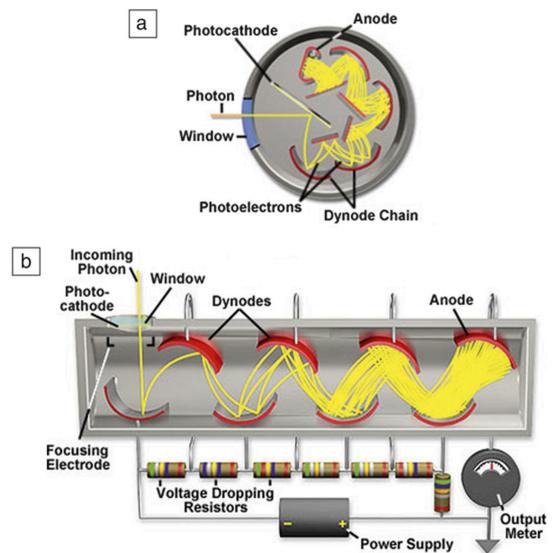


Figure 5: Common configurations for photomultiplier dynode chains; (a) side-on (b) tube (Trucchi, 2017)

to emitters. However, that does not mean no progress has occurred in the realm of collectors. We have an intermediate understanding of what requirements this component must fulfill. New materials and a more profound comprehension of the mechanisms that drive electron collection are currently being pursued and provide a strong direction for future research (Go, 2017).

We know from eq. 4 that maximizing power output means creating the greatest possible difference between the collector and emitter's work functions. This priority must be weighed against maintaining a relatively low work function for the emitter. Therefore, our work to discover new techniques to fabricate materials with lower work functions must continue to be aggressive. Collectors also play a vital role in TEC heat loss through two principal mechanisms. The first is through collecting electrons at levels above their own work function, meaning some electrons may receive more thermal energy than necessary to traverse the interelectrode gap and reach the collector successfully. This additional energy becomes wasted as the collector absorbs it and potentially risks preventing electrons from being collected. A suggested solution is to implement a grid-like structure near the collector surface to prompt tunneling into lower states before reaching the collector. The second is through the absorption of infrared light originating from the emitter. Incorporating materials with high infrared reflectivity can increase efficiency by minimizing the absorption of thermal radiation. Both these mechanisms result in the collector absorbing excess heat. If enough heat is absorbed, it can result in back emission, where the collector starts emitting electrons it has collected back into the interelectrode gap. This phenomenon can contribute significantly to space charge. Evidence suggests that choosing a surface material with a negative electron affinity (NEA) can help address this issue (Go, 2017; Abdul Khalid, 2016; Strohl, 2007; Trucchi, 2017).

Electron affinity refers to the energy changes that occur when an atom absorbs an additional electron and is typically the difference between the bottom edge of the conduction energy band and the vacuum level energy, as shown in figure 1. However, it is sometimes possible to design the vacuum level below the conduction band minimum, which would result in the shedding of energy by the collector instead of absorbing it. This reversal would promote more efficient electron collection, resolving the potential for back emission (Abdul Khalid, 2016).

Finally, lowering electrical resistance can reduce power loss, and evidence indicates that incorporating a high Richardson constant can help reduce electron reflectivity. However, due to uncertainties around the physics of emissions in novel materials with reduced dimensionality, new research should focus on any modifications to the Richardson-Dushman law that may be warranted. Additional focus areas should include developing comprehensive theory and simulation of collection and a database of materials and surfaces with complete theory, a deeper understanding of quantum tunneling and its role in emission-collection, and integrated collector designs that focus on nanostructures to facilitate tunneling (Trucchi, 2017).

### **Interelectrode Gap**

Advancements in the design of the interelectrode gap have primarily served to combat the effects of space charge. Proposed solutions have revolved around either neutralizing the net charge across the region or manufacturing the distance between electrodes to be as small as possible (Go, 2017).

One approach to both aiding emission and neutralizing the accumulation of negative charge in the gap has been to fill it with a vaporized, ionized alkali metal (Swifter, 2018). This process is slightly different from the technique mentioned above of adsorbing vaporized alkali metals onto the emitter. Here, the metal is ionized beforehand, without giving that valence electron

to the emitter's surface. Again, alkali metals' single valence electron makes them especially suited for this task. Cesium is often the element of choice because of its low ionization energy, around 3.9 eV. While the technique undoubtedly combats space charge and lowers the emitter's work function, it also has the unwanted side-effect of lowering the work function of every other surface it encounters. The inclusion of a reservoir for this ionized gas also places a limit on device lifespan. In their TOPAZ design, the Soviet Union approximated that a one-kilogram source of ionized cesium would have a lifespan of approximately one year. Additionally, the ionization process, which is performed by a low-voltage arc discharge, reduces converter efficiency by 30-50%. However, a recent study proposed further experimentation with a procedure requiring less energy input that combines a grid electrode and an applied magnetic field (Bickerton, 2017; Go, 2017; Abdul Khalid, 2016).

Another approach involves designing the interelectrode gap so small that there is not sufficient space for charge to accumulate, somewhere on the scale of five to ten micrometers (Swifter, 2018; Go, 2017; Trucchi, 2017). In addition to practical manufacturing challenges, at these distances, conduction also becomes an issue because of near-field radiative heat transfer. This phenomenon would grow by several orders of magnitude should the gap become too small. Russia experimented with a six-micrometer spacing design in 2001, but the converter ultimately proved mechanically unstable. Modern microfabrication, made possible by modular structures made of small emitter-collector assemblies, are currently being explored. They have remained stable for several hours at temperatures ranging from 900-1,400 Kelvin at distances of 100 micrometers (Go, 2017).

The use of spacers to minimize the gap and maintain a consistent distance between electrodes has been another strategy employed,

utilizing several approaches. One test run managed a 1.6-micrometer gap using microbead-type spacers, while another design saw a ten-micrometer gap using silicon oxide spacers. Unfortunately, the latter still experienced large thermal losses through contact with the spacers, about 0.4 W/K. While this approach to resolving space charge has its own unique challenges, the possibilities for devices designed with microscale interelectrode gaps are enormous. We should expect to see further developments in this technique (Go, 2017).

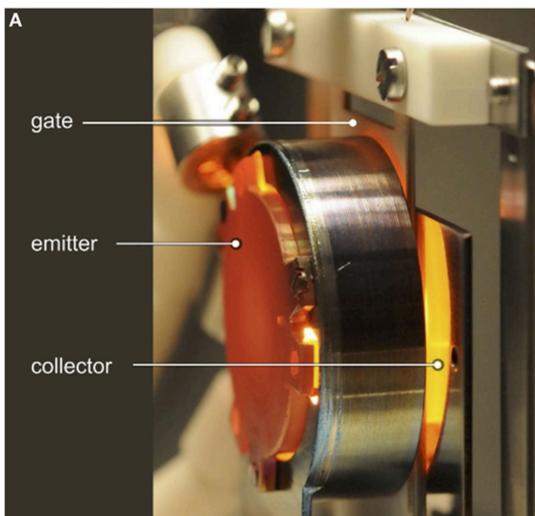
Interstitial gate electrodes have also been an exciting development that places a positively charged gate or grid in the collector-emitter space (Meir, 2013). Although this design requires wider spacing ( $\sim 100 \mu\text{m}$ ), imposing a potential of about 5-10 V makes it possible to facilitate electron passage and prevent potential electron clouds. However, gate currents, which refers to the positively charged gate siphoning electrons, must be suppressed, either by applied magnetic fields ( $\sim 0.5 \text{ T}$ ) or electron-transparent gate materials (Abdul Khalid, 2016; Wanke, 2016). The latter of the two could help contribute to the design of converters of minimal weight. This direction is promising, as it offers the possibility of tunable devices, adjusting parameters such as output power and cathode temperature. Also, larger interelectrode gaps provide increased durability and extend operational lifespan (Go, 2017).

Nevertheless, while models predict high-efficiency levels, as seen in figure 6b, further validation through experimentation is still needed. While current density is related to gap distance, it is also dependent on the width of the holes in the gate. While the highest-measured efficiencies are when both emitter-collector and gate holes are at their smallest, agreeing with predictions, fabrication and assembly continue to pose challenges in execution (Go, 2017; Mannhart, 2014).

### Applications

One could certainly argue that its broad applicability has been the driving force behind the ample amount of research poured into thermionic conversion. With their simplistic design, high potential efficiency, low maintenance, and long lifespan, TECs can address a diverse set of needs. They have been studied extensively, theoretically, in three leading contexts: as cogenerators, as parts of topping cycles, and as complete replacements for existing power suppliers (Go, 2017). As complete power source replacements, TECs are most adequately suited for space. In conditions that often occur millions of miles away from Earth with the Sun acting as the only energy source, TEC’s small design with virtually no maintenance requirements, paired with its compatibility with photoemission enhancement, all but guarantee ideal performance. In 1987, the Soviet Union launched two 5 kW nuclear-powered TEC’s aboard experimental satellites (Go,2017; Abdul Khalid, 2016).

Their roles in topping cycles position them in more complex energy-producing systems for efficiency purposes, contributing to larger-scale applications. Possible options include steam turbines at electrical and nuclear power plants and solar farms. Rasor Associates performed early research within this context in the 70s as



### B

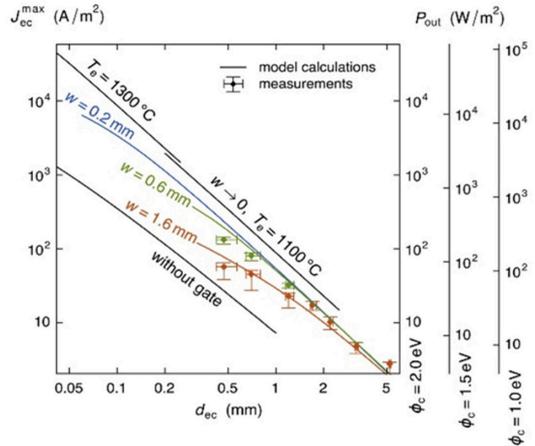


Figure 6: (a - left) Image of a thermoelectric converter using a positively charged gate in the collector-emitter gap; (b - above) Graph showing current density over gap spacing (Go, 2017). Adapted from Meir et al (2013) <https://aip.scitation.org/doi/10.1063/1.4817730> under CC BY 3.0.

the U.S. was exploring nuclear energy. Their study suggested employing TECs as topping cycles with fusion reactors could increase plant efficiency by almost 6% and generating efficiency by 27.6%. Preliminary data has also shown that in combination with diesel and gasoline combustion, integrating TECs provide benefits over internal combustion alone (Abdul Khalid, 2016).

However, TEC’s most residentially relevant application is probably as cogenerators. We are beginning to see private companies rising to this opportunity. In the ‘90s, a research group from Russia and the Netherlands designed a domestic boiler system that was available commercially. It produced about 1.5 kW of energy (Abdul Khalid, 2016). In Bothell, WA, a company called Modern Electron offers compatible homeowners an electrical substitution to dependency on current power grid infrastructure. Their device design, the details of which are not published, works in partnership with natural gas. 160,000 homes across the U.S. and Europe use natural gas to heat their homes and water. The TEC Modern Electron has produced integrates with a home’s water heater or furnace. A pilot light can burn at over 2,000 °C while only heating water to about 80 °C (Chao, 2016). The rest of

that energy is wasted. Modern Electron claims to have increased conversion efficiency by a factor of ten and lower operating temperature for emission, granting independence from the power grid, hundreds of dollars in annual savings, and decreasing the average home's carbon footprint by 1.19 pounds annually (modernelectron.com). In 2015, they secured \$10 million in funding and were recognized by Seattle as one of fifty start-ups to watch in 2019 (Osborn, 2019). With that level of traction, it is only a matter of time before we see competitors enter the market. TECs clearly have a promising future as cogenerators.

### Conclusion

The thermionics community has invested extensive research in energy conversion technology. That investment was not frivolous. With the evolving energy demands of the planet and the existential consequences we face from excess burning of fossil fuels, thermionic emission is a promising option. The world needs simple solutions. While the physics behind emission itself is not simple, leaving many questions left to answer, the technology's application is. Energy is challenging to produce in the same place we are using it (Chao, 2016). Many developing countries across the globe face this exact problem. TEC's ability to capitalize on waste heat, regardless of its source, offers an auspicious option for those communities. For developed nations, efficiency is what frequently drives improvement. TEC's ability to work in conjunction with other energy producers provides a valuable opportunity to take full advantage of the resources we consume. Moreover, in practically every scenario, their simple design, minimal maintenance requirements, potential high efficiency, and compact design outbid many other options. TECs are not going anywhere and have the potential to become the backbone of sustainable energy production solutions; their research must continue.

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# PHYSICS THROUGH TIME: DESIGNING A WATER CLOCK THAT CAN ACCURATELY TELL TIME

Sumaiya Sathar

*ABSTRACT: Throughout history Muslim civilization has contributed immensely towards so many aspects of life, from the discovery of coffee to the development of sophisticated technology. They have invented time measuring devices, irrigation machines, and entertainment devices, and made many important discoveries in the fields of science, astronomy, medicine, mathematics, geography, architecture, and more. Unfortunately, the contributions of non-European cultures, including those of Muslim inventors, are often overlooked and instead educational institutions tend to focus on the discoveries of European scientists, even if research by Muslim scientists is at the root of many of those discoveries.*

*This paper aims to highlight some of the contributions of Muslim scientists, specifically in the field of physics where Muslim inventors were well known for the development of various sophisticated time keeping devices. To gain a better understanding of the underlying physics behind water clocks, a literature review was conducted primarily on papers published by the Institute for Science and Technology in Islam and by the Royal Society of London.*

*The papers investigated the mechanism of the Fez clock, as well as the best vessel shape and hole diameters for the simplest clepsydras. Findings from the papers suggest that the best vessel shape for a clepsydra is a quartic vessel with a 0.5-1.0mm diameter hole and that a float system was present within the Fez clock. It is unknown whether the Fez clock had a quartic vessel in its design, but it is worth noting these findings as the earliest scientists may have conducted such experiments themselves and used the data collected to design the astounding clocks we see now.*

## Introduction

Although time-telling has been important to many nations and cultures, it was not until the emergence of Islam that its technology and sophistication was given an enormous boost. Islam is a religion that recognizes the significance of time and appreciates its seriousness. The prophet Muhammad, peace be upon him, taught Muslims that time is a blessing that must be valued and used wisely. There is even a chapter titled “The Time” in the Quran, the holy book which Muslims adhere to, which emphasizes the importance of time and encourages Muslims to both reflect on the passage of time and use time to do good.

The lives of Muslims are structured around the five daily prayers, each of which must be

prayed during a specific time of the day. Fajr is prayed at dawn, Dhuhr at midday, Asr in the mid-afternoon, Maghrib at dusk, and Isha at night. During the month of Ramadan, Muslims must again watch the time closely so they can start their fast at dawn and break their fast at dusk. It is no surprise then that time-keeping devices were of the utmost importance amongst Muslims. Of the many time keeping devices developed, water clocks are one of the earliest devices in the history of mankind. There are several examples of time-keeping devices from the Muslim world, including Caliph Harun al-Rashid’s clock that he gifted to Charlemagne and Ibn Al-Haytham’s novel water clock, to name a few.

The use of the water clock can be tracked all the way back to ancient times. The very first

water clock was just a simple vase with a hole, known as clepsydra, and was found in ancient Egypt. It consisted of a vessel with a small hole at the bottom. The vessel was filled with water to a fixed mark, then allowed to drain. This allowed a constant interval of time to be marked out. Another type of clepsydra was a perforated bowl placed upon water, and it was considered to take a constant time to fill up and sink.



This figure shows the oldest specimen of a clepsydra to have survived in a well enough condition to be fully reconstructed. It was excavated at Karnak in Upper Egypt and is dated to about 1400 B.C. Reproduced from Mills A. A. (1982) Newton's water clocks and the fluid mechanics of clepsydrae. *Notes Rec. R. Soc. Lond.* 37(1) 35-61 <http://doi.org/10.1098/rsnr.1982.0004> with permission of The Royal Society

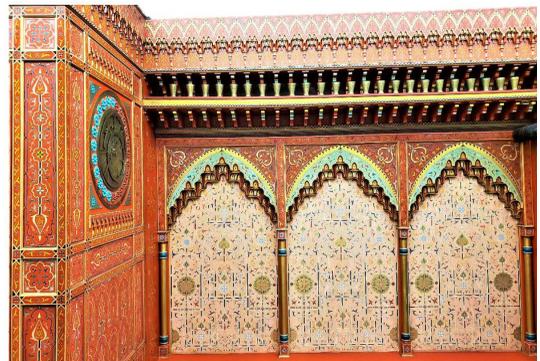
After the development of the clepsydra, we find many models of water clocks around the world, especially in Muslim countries where time measuring devices are central in society. One can see examples of these clocks in Mosques from Baghdad to Damascus to even Morocco. These water clocks were a combination of engineering and artwork and used very complex mechanisms, some of which were forgotten over time and were not very well known.

The clocks were especially useful during the night when sundials could no longer be used. The Al-Lija'i clepsydra clock, located within the minaret of the Al-Qarawiyyin mosque in Fez, Morocco, is the oldest extant water clock known and was built by the muwvaqqit (a title given to the astronomer who oversaw the calculation

of prayer times) of the Qarawiyyin Mosque back in the 1300s, Abu Zayd Abdurrahman bin Sulayman Al-Leja'I.

## Literature Review

The Fez clock divides the day into 24 hours. The dial is divided into four minutes each. Water inflow was calculated so that it remained uniform every second of the day. Within the clock there is a sinking float and two carriages. The first carriage holds small brass balls, and the second holds larger brass balls. The sinking float causes a minute pointer on the dial to move every four minutes. The movement of the minute hand causes one small ball to fall into the corresponding brass bowl (out of the 24 total bowls), making a ringing sound, and the movement of the hour hand results in the dropping of a larger brass ball, which makes a larger ringing sound (Institute for the History of Arabic-Islamic Science).



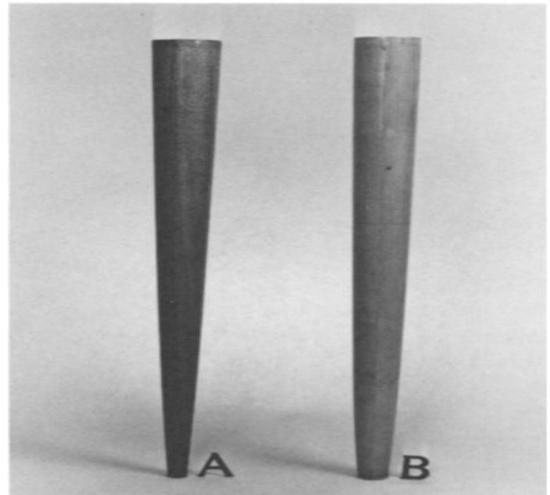
Model of Al-Lija'i clepsydra clock located in the room of Al-Muwaqqit in the Al-Qarawiyyin mosque in Fez, Morocco. This is the oldest extant water clock known. It was used by Muslims to determine prayer times and dawn/dusk for days fasting. The clock is currently being studied and restored to working condition. - Source: Moroccan water clock model, Istanbul Museum of the History of Science and Technology in Islam, Istanbul, Turkey (own photo).

In addition to the sound of the brass balls falling, one of the 24 wooden doors behind the bowls closes, which gives an overview of the hours elapsed and can be viewed from afar. Then the carriage moves to the next brass bowl and the pattern continues. There are two types of water clocks: clocks that depend on inflow of water and clocks that depend on outflow. Both

the clepsydra and the clock in Fez depend on outflow of water. The volume of water dictates the sinking of the float to which all these other components are attached, but the clock has been designed in a way that the two carriages move opposite to the direction of the sinking float, even though they are connected by a pulley-like system (Institute for the History of Arabic-Islamic Science).

**Methods**

Water clocks depend on physical properties to function, such as buoyancy, pressure, angular velocity, viscosity, and flow rates (Al-Hassani). I was interested in learning more about the Fez clock and the mechanism behind it. In my research, I came across a study published by a group of scientists who determined what vessel shape, hole diameter and capillary size would



This figure shows the shapes of the vessels used in the experiment. Figure A is a parabolic vessel and figure B is a quartic vessel. Reproduced from Mills A. A. (1982) Newton's water clocks and the fluid mechanics of clepsydrae. *Notes Rec. R. Soc. Lond.*37(1) 35-61 <http://doi.org/10.1098/rsnr.1982.0004> with permission of The Royal Society

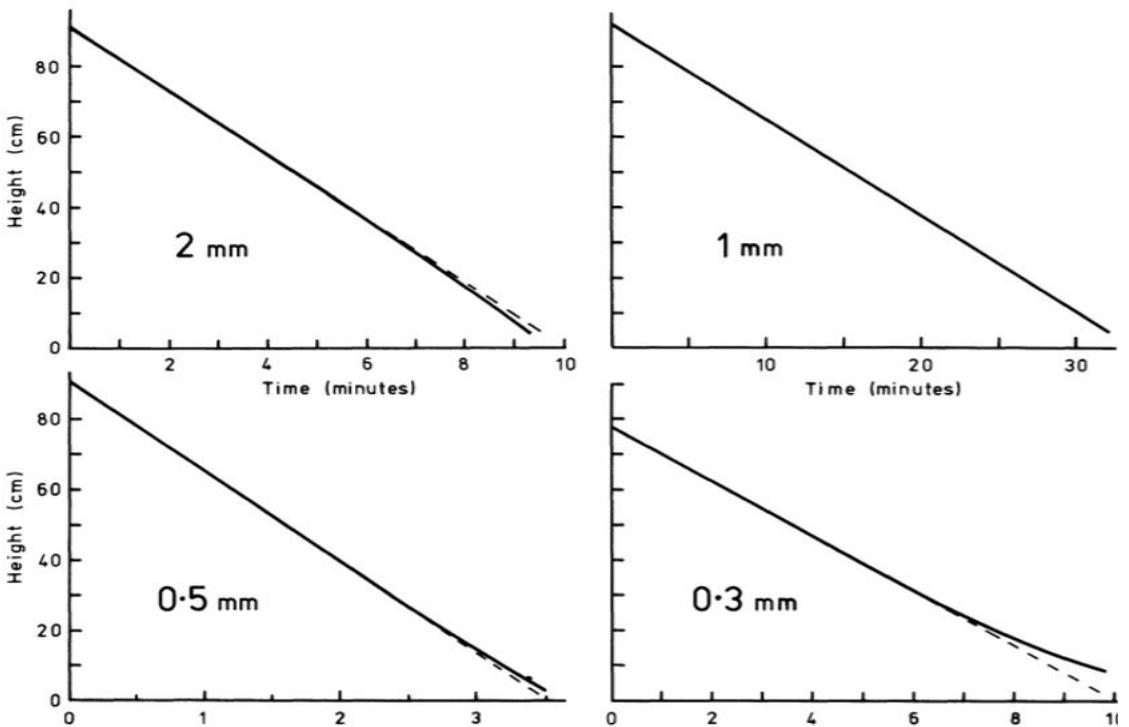


Figure 1 - These graphs show the rate of fall of water-level with time in a quartic vessel draining through holes of the indicated diameters. The solid line is the rate of water flow based on the data collected, and the dotted line is the ideal linear graph should the water flow consistently. We can see that these graphs are quite linear, which means that the water tended to flow at a consistent rate. The most linear is the vessel with an aperture of 1mm, and the one that was the least consistent is the 0.3mm. Reproduced from Mills A. A. (1982) Newton's water clocks and the fluid mechanics of clepsydrae. *Notes Rec. R. Soc. Lond.*37(1) 35-61 <http://doi.org/10.1098/rsnr.1982.0004> with permission of The Royal Society

result in consistent flow based on their research of the clepsydra. Translucent fiberglass was molded to make two long, narrow vessels, one with a more quartic shape and the other more paraboloidal. Apertures were made by drilling 0.30, 0.50, 1.0, 2.0 and 3.0mm diameter holes in 0.1mm thick brass foil. The capillaries were made of 100mm glass precision tubing, with holes of diameter 0.5, 1.0, 1.2, 2.0 and 3.0mm. Tests were conducted using room temperature water to maintain constant viscosity (Mills).

The vessel was supported vertically, and the end was taped. Water was then poured in and some time was given for the water to stop bubbling and to settle. Afterwards, the adhesive tape was removed. At certain times on the

stopwatch, the position of the meniscus of the water was marked on the tube until the vessel was empty. After that, the height of each mark was measured and plotted on a graph (Mills).

**Results**

After collecting the data, the scientists went on to graph their results based on the height of the meniscus over time. They then used these results to determine which graph looked the most linear, indicating a more consistent rate of water flow. The first figure is of the quartic vessel that used apertures of different diameters. The quartic vessel graphs were quite linear, particularly the vessel with the 1mm hole (Mills).

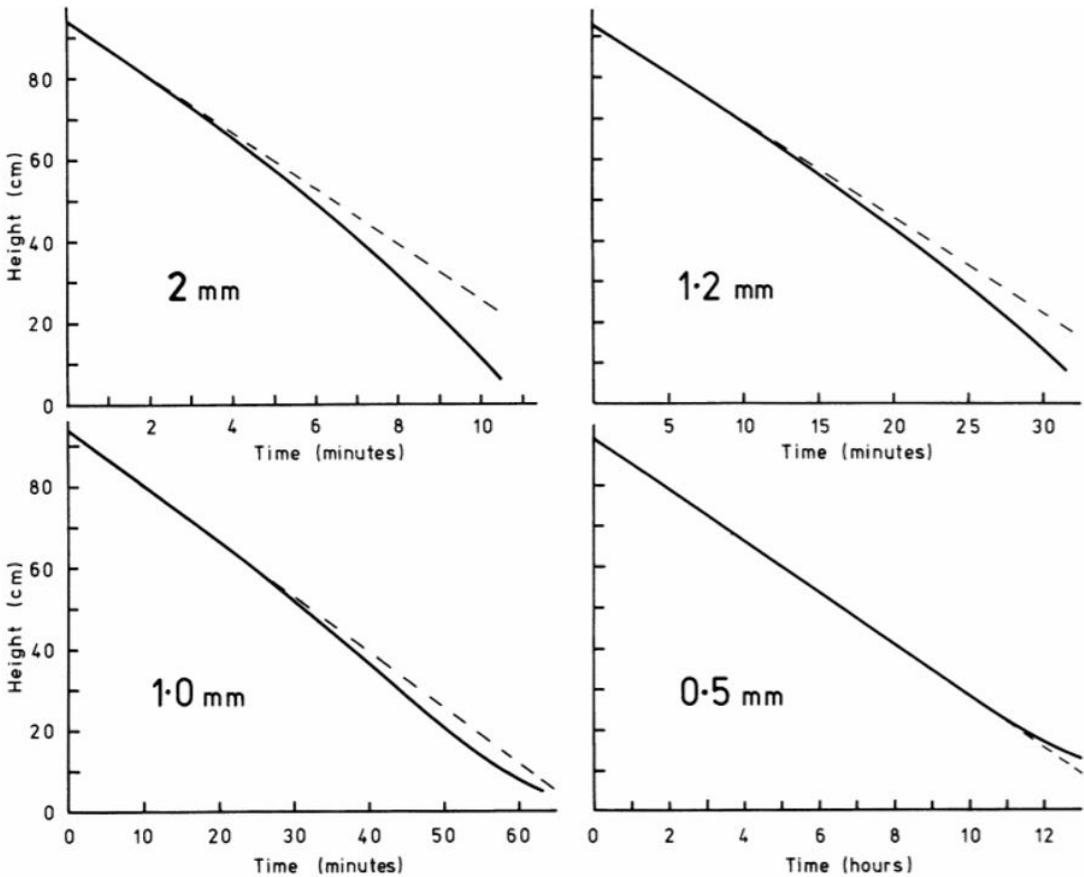


Figure 2 - This figure depicts graphs that show the rate of fall of water-level with time in a paraboloidal vessel draining through capillaries of the indicated internal diameters. Compared to the quartic vessel, the paraboloidal vessel is much more inconsistent with the rate of water flow. Of these four capillary diameters, the most linear was the smallest diameter, which was 0.5mm. As the diameter of the capillary increases, so does the inconsistency of the waterflow, so smaller is better. Reproduced from Mills A. A. (1982) Newton's water clocks and the fluid mechanics of clepsydrae. *Notes Rec. R. Soc. Lond.*37(1) 35-61 <http://doi.org/10.1098/rsnr.1982.0004> with permission of The Royal Society

The second figure is of the data plots for the rate of water-level with time from paraboloid vessels that used capillaries for the water to pass through. Compared to the quartic vessel, the paraboloid vessel graphs were not as linear, indicating that the rate of flow was not as consistent, especially as the volume decreased. Out of the four capillary diameters tested, 0.5mm gave the most linear graph (Mills).

## Conclusion

Based on experimentation we know that between a quartic and paraboloid vessel, a quartic vessel was better for controlling water output. In addition, by comparing the graphs, scientists were able to determine that, of the different diameters tested, the 0.5-1.0mm diameter turned out to be the best width for constant water flow. It raises questions as to what vessel shape was primarily used in the creation of water clocks such as the clock found in Fez.

Additionally, the history of the water clock and other scientific advances highlights the importance of studying the contributions of Muslim scientists and inventors from non-European countries. Many of the important inventions and discoveries made by Muslim scientists are often overlooked and those scientists are not properly acknowledged. Not only will studying such contributions bring new perspectives, awareness, and a greater appreciation of their amazing contributions, but it will also bring to light a part of our history that is often overlooked and help fill in the hole in our understanding of the past.

Without the contributions of Muslim scientists, we would not have acquired the knowledge we have today at such a fast rate, and it is time we acknowledge all the inventors that have shaped the world as we know it today and study their contributions in all fields of study.

## Acknowledgements

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# SCIENCE, SPRITS, AND SPECULATION: EDGAR ALLAN POE AND THE METAPHYSICAL BATTLE BETWEEN EMPIRICAL AND SUPERNATURAL

ANNIKA G. RUNDBERG BUNNEY

*ABSTRACT: From 1827 to 1849, Edgar Allan Poe wrote volumes of work that inadvertently documented his downward emotional spiral and internal struggle between wanting to believe fully in the spiritual or the empirical. By analyzing a selection of his works alongside his history, it can be seen that his writing reflects his internal metaphysical struggle. Unable to come to terms with the empirical reality of loss, Poe frequently weaves supernatural features into the worlds he creates, attempting to reconcile the unalterable facts of the natural world with the metaphysical hopefulness of spirituality.*

*Keywords: Edgar Allan Poe, Empirical, Spiritual, Supernatural, Poetry, Story, Writing, History*

## Introduction

Known for his macabre and often tragic works, Edgar Allan Poe was a master of weaving together the fantastical and the real. From his famous poem “The Raven” to the lesser-known work “The Colloquy of Monos and Una,” Poe invariably draws upon supernatural elements to explore life and death in his storytelling. He uses mystery, monstrosity, and the flaws of mankind to manipulate readers’ understandings of the worlds he creates and continually references. He pulls elements of his environment into his narratives and alters them to fit his needs at the time. Poe’s own life adds to the mystery, as parts of his biography are lost to the ages. As a thinker, much of his writing echoes his ever-shifting mindset as a man tortured by his own circumstances in an upheaved world. By contrasting analysis of both his writing and his life, light can be shed onto his literary habits and repeated allusions to his intellectual struggle between believing in the empirical or scientific elements of the world and relying on the supernatural or spiritual perceptions of the world.

## A Biography of Poe

Edgar Allan Poe (1809-1849), born during the beginning of the American Industrial Revolution, had a tumultuous life. Many of the themes in his biography are reflected in his writing, with death and loss being the most prominent. With empirical medical studies on the rise, his misfortune was somewhat uncharacteristic of the time, and this likely led him to find frustration with the scientific process. He seemed to want to believe the empirical facts, but Poe’s own life pushed against the narrative of medical progress. He first suffered loss at the age of three when his parents, both professional actors, died, leaving him alone in Boston, Massachusetts. Not much is recorded about how this loss affected him, but it can be recognized that it left a lasting impression on him. After becoming the foster child of Frances Allan, whose name he eventually added to his own, Poe spent the rest of his childhood in Virginia, only leaving to attend the University of Virginia in Charlottesville. Academically, he did well but succumbed to the allure of gambling and drinking. In a little under a year, Poe racked

up large gambling debts, which his foster father Allan refused to pay. This irreparably damaged their relationship, and Poe eventually moved back to Boston where he enlisted in the United States Army in 1827. This is also the time when his documented writing journey began, and his works started to be published (Poets.org). Due to his frequent movement and lack of steadiness in his employment, his works – dissimilar to one another and covering a wide variety of topics – reflect this inconsistency of both his own life and the world around him.

Poe lived during one of the most turbulent eras of American history. During the 1800s, the United States was turned on its head, with science giving rise to new developments that ultimately rewrote society's standards of living and beliefs. The supernatural or the spiritual began to become outdated as science answered difficult questions around topics such as death, illness, and the natural order of the world. The empirical – an observable, documentable source of information – dominated, and American society began to apply this new knowledge to anything it could. Historian Jeff Horn describes the American Industrial Revolution's success as hinging on the invention of machinery with interchangeable parts, creating a uniformity both for workers and the parts produced. These machines could make "...metal parts for products ranging from clocks, to cash registers, to typewriters, to reapers, to locomotives, and finally to automobiles" (Horn, 4). These machines effectively superseded the human aspect of everyday creation, making products safer, cheaper, and easier to replace. Despite the novel inventions, some were still wary of the repetitive and exacting nature that overtook the individuality of handmade technologies. The new empirical data gathered as more technology was implemented was also applied to medicine, especially as more sanitariums and hospitals were being built in conjunction with an increase in diseases like widespread tuberculosis. Still, with declining mortality and higher health standards leading to increased fertility, there was

a social boom that brought the need for more infrastructure and urbanization (Horn, xxiv). This development pushed the supernatural – traditional stories, beliefs, and ways of living – to the wayside. The natural world overtook the supernatural, becoming the focus of academics and laymen alike, with new research coming to light seemingly every day.

In the 1800s, the natural world was being reexamined as science progressed to overwrite itself. As this turnover occurred, the antebellum South of the United States also began to break free from its status quo, igniting the raging politics of the Civil War. Having been a soldier, Poe had insights into the political landscape that those both outside of and higher up in the military had. While he served during a time of peace, he was taught about the horrors of war and fighting, as well as the bureaucratic battles that take place during such an event. As U.S. Army historian Clayton Newell explains, even before the Civil War, the United States Army was viewed primarily as "a necessary evil at best" (7). The massive losses of life resulting from the decisions of those who never saw a battlefield ate at Poe, who was no stranger to loss. According to the U.S. Army's Chief Historian, Richard Stewart, there were more than 600,000 deaths in just the years that were officially considered a part of the Civil War, but like most civil wars, the tension and fighting long preceded the formal beginning of the political battles (5). It was these losses that likely led Poe to more thoroughly explore the possibilities beyond life and death – beyond mere mortals fighting over ideologies and politics. In his poem "Spirits of the Dead," which Poe wrote in 1827 during his military posting, he considers life after death and the journey from the plane of mortality to the heavens. He advises the dead to "Be silent in that solitude, / Which is not loneliness..." (Poe, 26). He explains that the dead will not be truly alone, for after death, they will join everyone who has died before them. Later in his life, the references to loss drastically increase as his world becomes darker, incorporating more

mythologies and classic literary references he learned though his stints in higher education.

As a way to expand his understanding of the empirical and literary worlds through academia, Poe attempted to continue his education at the United States Military Academy, but again had to leave due to a lack of financial support. Because of this, he began to write and sell more of his work. Some of these pieces included short stories and poems such as “Imitation” (1827), “Mysterious Star” (1831), and “A Tale of Jerusalem” (1832). His work focused on short stories and poems, with themes of adventure, exploration, and questioning of the empirical world. In 1835, he became the editor of the *Southern Literary Messenger*. One year later in 1836, he married his young cousin Virginia, sometimes attributed as being one of his muses (Poets.org).

Virginia’s story is similarly muddled to Poe’s, the documentation of her life greatly lacking. However, it is known that they began a friendly relationship during a period in which Poe temporarily lived with his aunt, Maria Clemm, and her daughter, Virginia. During this time, Poe wrote and published two volumes of poetry. When Poe finally married her several years after his tenancy with her family, she was only thirteen years old while he was twenty-seven. It is believed that Poe altered her age to be eighteen on their marriage certificate (Johnston). Poe was continuously writing throughout their relationship, some of his writing focusing on the playfulness of the relationship with his young wife and the imaginary adventures on which he wanted to take her.

After he was married, Poe became known for his scathing criticism of his fellow authors. His book reviews are especially well-known for their shortness and heavy criticisms of fellow writers. He earned the nickname “The Tomahawk Man” from his vicious reviews, his style easily recognizable during the era. Author Brett Zimmerman adds, “...Poe’s reputation for

critical severity had become so widespread that he even found himself being blamed for scathing reviews he did not write” (86). His book review format – the critical eye on contemporaries – garnered its own following, likely due to the entertainment provided by “literary wars” ignited by Poe’s aggressive nature. His mentality throughout adulthood contributed to this aggression: “...he lived his adult life feeling like a man of genius surrounded by dolts, boors, pretenders, toadies, sycophants...these unworthies often did get undeserved praise while Poe, whose brilliance deserved so much better, struggled, if not in obscurity, certainly in poverty” (Zimmerman, 91). Feeling oppressed by the ever-changing society in which he lived and those who lived within it, Poe held back no sharp quips or ranting criticisms in his critiques. He was bitter over the lack of recognition, and with his work at journals and newspapers becoming more strained, Poe began to slip into writing more personal stories and poetry about his frustration, dismay, and overall melancholy. Slowly, his work devolved into focusing on his misfortunes and the feeling of being betrayed by science and the empirical world while simultaneously cursing the supernatural for not presenting him with any kind of miraculous solution.

The misfortune in Poe’s life and the world surrounding him did not cease. His most devastating tragedy struck in late 1847 when his wife, Virginia, died from what is believed to have been tuberculosis (Poets.org). It was in this year that his most famous works were published, including “The Tell-Tale Heart,” “Lenore,” and “The Mask of the Red Death: *A Fantasy*.” His bouts with depression and alcoholism worsened after Virginia’s death, and his writing began to turn from a broad exploration of topics to a focus on the demise of beautiful women. This era of his writing is often referred to as being what provided him his standing as an established American writer, even though he sold and published his renowned poem “The Raven” for only \$9 (World History Edu). Until his death,

Poe continually drew upon these deathly themes as well as feminine frailty and mortality, driving a narrator to madness and heartbreak. It is to this image that academics often return in their studies due to its dark allure.

According to the National Park Service and the Edgar Allan Poe National Historic Site, Poe's death is still debated and is the greatest mystery he left behind. By 1849, despite the fact Poe's depression and alcoholism had become severe, he still accepted an editing job in Philadelphia. On September 27, 1849, Poe left Richmond and inexplicably stopped in Baltimore, where he would die several days later (Poets.org). Not much is known about the events following September 27th. Cooping, a type of voter fraud involving a person being forced through intoxication or drugging to cast several votes, is proposed as a main cause of death, with the substances used being a catalyst for his body to collapse. On October 3rd, he was found collapsed on the steps of the State House, wearing clothes belonging to another man, barely alive. While it was never discovered whose clothes he was wearing or what medical emergency caused his body to fail, it was surmised that he may have been in Baltimore with the intention of voting, as it was an election year. With what credible information has been preserved, cooping is a logical explanation for his death: he was in a disguise, clearly under the influence of some substance, and was near a polling place. However, other theories, such as rabies and complications from being mugged, still persist. No firm evidence exists to confirm his method of death, but it was recorded that he spoke to imaginary figures, including a woman he referred to as his "wife," as he rambled on in fervor before his inevitable and torturous demise (National Park Service). Despite the events leading up to his death being unclear and otherwise unknown, it is evident that his internal metaphysical battles blended into his consciousness. His last acts of life involved a dissolution between imagination and reality.

## Examining Poe's Works

While the beginning of Poe's literary explorations cannot be pinpointed, there are a few major milestones in his writing career including early poetry, newspaper articles, a lone novel, short stories, and his later poetry for which he is famous today.

One of Poe's early poems, "Tamerlane," published in 1827, focuses on a Turkic conqueror and his fictionalized journeys. It can be found accompanied by Poe's footnotes, where he discusses his research and process. It is clear he had begun to experiment with the manipulation of reality, although not to a supernatural degree. Instead, he decides his character – the titular Tamerlane – should be a friar and not the son of a shepherd as he historically was suggested to be. Poe says, "It does not pass the bounds of possibility – quite sufficient for my purposes – and I have at least good authority on my side for such innovations" (38). The reality was not enough for his story. A solitary shepherd's son did not conjure as much allure as a "holy friar" to whom a lost soul could turn. This reflects Poe's own need, as a young man alone, to find a guiding figure in his life. As an author, he bent reality to fit his needs at the time. Poe also imbued some of his own emotional and intellectual states into his work, and "Tamerlane" is no different. In the middle of the poem, he states, "For I was not as I had been; / The child of Nature, without care, / Or thought, save of the passing scene. –" (Poe, 29). While the poem is about the conqueror Tamerlane, these lines call out to a distraught Poe, caught between empirical realities and spiritual beliefs. He felt he could no longer avoid the need to be intellectually involved in the world around him. As an adult, he was informed of scientific discovery and progress, yet he tried to hold onto his childhood, as traumatic as it was. It is in this poem that Poe appears to begin his understanding that, regardless of the world around him, he was the master of his own writing, and he could alter anything he wanted. The worlds he created were

based in reality, but he quickly discovered that they need not stay that way.

In struggling to mesh the scientific and the supernatural, many of Poe's works find themselves with a haunting tone, especially his later writing. This is achieved through a manipulation of reality, as Poe plays with the dark beauty of the natural world in conjunction with his seeming fascination with the macabre supernatural. His many references to dark waters churning on rocky shores and the pitch-black of the night preoccupy much of his later works, yet the presence of the supernatural reaching beyond his earthly realm is still present. Author Bettina Knapp explains, "Poe's tales take place both within and without the rational objective world" (3). While he draws on the world around him, he also creates his own from it.

One example comes not from his personal writing, but from an article written for the *New York Sun* on April 13, 1844. Commonly referred to as "The Balloon Hoax," Poe wrote a column whose title reads "Astounding News! By Express Via Norfolk! The Atlantic Crossed in Three Days! Signal Triumph of Mr. Monck Mason's Flying Machine!!!" (The Edgar Allan Poe Society of Baltimore). In the article, Poe imagines a plausible invention of a flying machine which can cross the Atlantic Ocean in

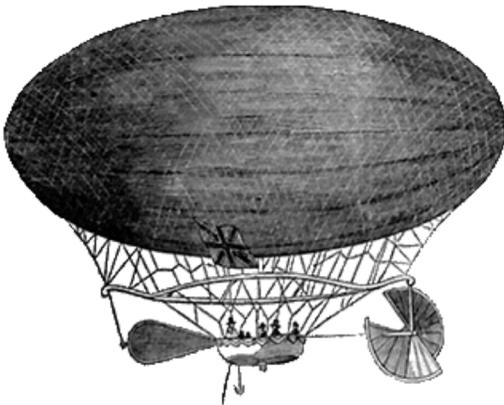


Figure SEQ Figure \\* ARABIC 1. Model of the Victoria, the flying balloon machine Poe created for his falsified article (Edgar Allan Poe Society of Baltimore).

just three days. He relates the incredible balloon to the English inventor and engineer Sir George Cayley, a credible and very real authority on flight. Poe's choice in referencing him was certainly not unplanned. Sir Cayley was a prominent academic in the 1800s and is often considered the father of aeronautics, a prolific inventor of flight-based machine blueprints (Gray). By using reliable and known sources to help bolster his own credibility, Poe was able to create narratives that slipped through the cracks of the traditional storytelling methods. He included diagrams (Figure 1) and specific measurements of the imaginary machine's components to add a further level of credibility, as imagery reinforcing the imaginary was important to him. On April 15, 1844, the balloon statement was retracted. According to The Edgar Allan Poe Society of Baltimore, the author of the retraction is unknown, but it was likely to have been Poe himself. He asserts the possibility of an imaginary event, drawing upon a blend of empirical and fantastical elements. In the conclusion of the retraction, the unnamed author states, "The description of the Balloon and the voyage was written with a minuteness and scientific ability calculated to obtain credit everywhere, and was read with great pleasure and satisfaction. We by no means think such a project is impossible" (The Edgar Allan Poe Society of Baltimore). Whether or not the retraction was written by Poe, it is clear the story was bought by readers, who fell for the ruse due to how detailed it was. However, the invention was one of Poe's imagination, a concept of a possibility he worked to sell as a believable tale. This manipulation of reality developed throughout his writing career, although it was usually accompanied by a struggle between relying on what he knew to be true – the empirical – and that which he'd been originally taught to be true – the spiritual.

Finding himself caught between science and supernatural, Poe became an authorly inventor, creating fantastical scenarios that were believed not only because of his specificity, but because

the world was in an era of industrial development. Great minds were constantly churning out new ideas, and Poe was no different. He worked from within, his writing drawing upon thinkers of the time, his own imagination, and general worldly observations.

...Poe was a thinking type who felt most comfortable in the abstract, impersonal, rational sphere. Mentally, he was forever exploring, learning, inquiring into the known and the unknown. He read omnivorously: poetry, fiction, scientific and mathematical treatises, mystical and metaphysical tracts...The universe was for Poe a living organism, a single form that, when manifested, acquired multiplicity (Knapp, 6).

He devoured content which fueled his writing and instability. He fought with the empirical facts laid out but struggled to reconcile these facts with the observations of his life. The devouring of content tormented Poe, and he continued writing as further exploration of these ideas in conjunction with his own imagination. As an author, he was able to follow his own interests and curiosities, including the impacts of death both on the deceased and those left behind. The empirical and spiritual battled within his mind, and he was so distracted by the internal metaphysical conflict, that he spent more time thinking alone than living in his environment. He created his own environments, sometimes fully fleshed-out within his writing, in which he could think and experiment.

One such environment was a novel he wrote in 1838, entitled *The Narrative of Arthur Gordon Pym of Nantucket*. It is a tale that weaves imagination and fact through the uncertainties of existence and divine intervention. The story follows Pym, a man out for adventure, as he explores the vastness of the uncharted ocean and untrekked mountains. His misadventures also include many supernatural encounters, such as a ship manned only by corpses, the

land whose inhabitants have never seen the color white, or the labyrinth with no known architects, though none are quite as mysterious as the “white figure.” Toward the end of Pym’s story, an unexplained white figure appears, and Poe never addresses its presence. This figure draws much attention due to its oddity, a creature that appears just before Pym’s narrative is suddenly ended. Author John Tresch, in his study of *The Narrative of Arthur Gordon Pym of Nantucket*, connects typography and historical revision to Poe’s writing, finding parallels between the white space on the page and the inexplicable white figure. “...perhaps we are meant to see the white figure as the outward representation – for the characters, or for us – of the unrepresentable: a mystical experience, or an encounter with divine truth...” (18-19). Perhaps it is less than that – a literal reference to the blank spaces on white pages, playing with typographical form and the limits of the printing press. Having worked with the printing press before, Poe was aware of its capabilities. Perhaps, instead, it is Poe’s representation of death in the empirical world – a mysterious event that ends the narrative of all those with whom it comes in contact.

However, despite his many references to the supernatural throughout his writing career, Poe also considered the natural world as an explanation for what once had been attributed to the divine. Author James Hutchisson approaches Poe’s work with a more cynical eye, focusing on scientific possibilities for references to supernatural or mysterious elements left to the imagination of the reader. “...Poe had a working knowledge of Scottish physicist Sir David Brewster’s *Letters on Natural Magic* (1831), in which Brewster describes dozens of optical illusions. He [Brewster] debunks these illusions, which were formerly attributed to the supernatural, by explaining how reflection, refraction, and the physiology of the eye work together to produce otherworldly effects” (Hutchisson, 119). Poe, an avid reader, believed in the rigor and methodology of science, but he

did not participate in gathering the empirical data. He was interested more in the results of science, the physical representation that empirical studies had been executed and conclusions had been drawn. It is seen from Poe's writing, especially earlier on in his career, that he often dabbled in scientific theory, as it was a prominent topic during his time. In a poem he wrote in 1829, entitled "Sonnet – To Science," he struggles to find harmony between scientific discovery and cultural tradition. "Science! true daughter of Old Time thou art! Who alterest all things with thy piercing eyes. / Why prey'st thou thus upon the poet's heart, / Vulture, whose wings are dull realities? /How should he love thee? or how deem thee wise" (43). Even in his writing, Poe struggled to reconcile scientific discovery with his own imagination and stories prominent in Western culture, especially mythologies and traditional tales passed down through the generations. "Sonnet – To Science" is a more explicit exploration of this struggle, and Poe, standing steadfastly as a poet, addresses science as a creature that goes to harm the imagination and the mythological. Yet, he was not afraid to acknowledge the intellectual changes occurring in the culture around him. The academic world was rearranging itself, science imposing itself upon the supernatural, erasing it, and upheaving the stability on which thinkers of the time had previously relied. From the Industrial Revolution to the Civil War, science and society were drastically changing, and those living in American society needed to change with them. While many adapted without much issue, Poe struggled to follow suit, and his later writings prove to be solid evidence of this.

Taking a close look at "The Raven," one of his later works that reflected the downward turn of his psyche, it can be seen how Poe began to create more writing encapsulating his own mental state. Essayist Dennis Eddings observes, "The narrator...follows a progression seen in many of Poe's tales where the abdication of reason in favor of the dark side of the imagination is ultimately destructive" (161).

Poe was slowly falling victim to his depressive episodes, both his characters and himself destroying their ties to reality through wishing for some supernatural intervention to their misery. "The Raven" features a man alone, his loved one lost to death, asking questions to a creature whose answer he already knows. In an empirical mind, would have deduced the answer and ceased his questioning, but in desperation or insanity, he continues to ask questions of the talking Raven. Poe's inability to come to terms with the physical death of his beloved wife and the empirical fact that her body would decompose and be lost forever, he attempted to turn to the spiritual but struggled to ignore the progression of scientific discovery. This internal conflict led Poe to continue his downward spiral into emotional turmoil and overall misery. Even with final works, some of which focused on writing processes rather than presented any mystical and melancholic tales, he could not find balance.

In April of 1846, Poe penned an essay entitled "The Philosophy of Composition" where, after receiving an inquisitive note from Charles Dickens, he describes his method of writing "The Raven" and correlates it to his overall process. Unlike his previous dabbling with science, where he focused on content and results, Poe spent much time in his later years mulling over scientific methods. As with much of his life, these empirical aspects bled into his writing. In his essay, he states, "...the work proceeded, step by step, to its completion with the precision and rigid consequence of a mathematical problem" (Poe, 1081). Poe applies the empirical method, a decisive step-by-step process, to the more fluid art of poetry. However, this balance between rigidity and flexibility created the originality for which he is still revered today. "My first object (as usual) was originality," Poe explains, "The extent to which this has been neglected, in versification, is one of the most unaccountable things in the world" (1085). His originality stemmed from his ability to think in two minds: the empirical and the fantastical. He

struggled with his own writing process, clearly wanting to indulge in the illogical and artistic tendencies of his imagination but also wanting to stay a rational man. He longed to allow himself complete creative control over his own works, but the oppressive presence of science and technological progress seemed to weigh heavily on his tortured mind. So, there he was, writing a highly structured poem about a talking corvid. He clings to his rigidity with the form and draws in the supernatural with his content. Even as he reviews his own work in a clinical manner, breaking it down to the basest parts, he is convincing no one but himself of the method to his madness.

## Conclusion

The tension between the natural and spiritual worlds made Poe's work alluring. It will continue to be studied as a great example of Romantic literature and pioneering of new writing forms, his work capturing a multitude of styles, emotional changes, and intellectual threads. Struggling to find balance contributed to the creation of his style and tone, as well as dictated the way in which he conducted himself.

Poe encapsulates in his works those polarities which hounded him: the empirical and spiritual worlds. These seemingly incompatible domains are meticulously structured in his tales: each is wrought in great detail, and each searches through the rubble of the lives he brings to his readers for insights, for ways to right a wrong, to balance the warped, harmonize conflict, and discover truth (Knapp, 205).

His work reflects how his state of mind slowly became darker and more introspective, the comparative cheerfulness of his youth dissolving into the melancholy of adulthood. His attempts to balance empirical discovery and internally warped perspectives of life, death, and everything in between resulted in classic American writing that lives on his legacy.

As a pioneer of many forms, Poe's work appears to have been driven by his insatiable need to explore and experiment, to explain the unexplainable, and to create stability in his own world. The intellectual communities surrounding him were constantly changing, new information blending and clashing as it fought for dominance. Poe's writing reflected this, his struggles with the metaphysical are prominent in his works, especially after Virginia's death in 1836. Poe's constant need to reconcile the natural and spiritual worlds forced him to create his own where the supernatural was the normalcy while empirical methodology persisted.

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# BIOLOGICALLY ACTIVE COMPOUNDS LIKE ASHWAGANDHA AND GINSENG WORK AS STRESS RELIEVERS AND ALTERNATIVES TO ANTIDEPRESSANTS

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*ABSTRACT: With 77% of Americans experiencing stress related symptoms on a daily basis, stress management has become a serious issue (NIMH, 2018). The most common course of treatment for stress management is to prescribe antidepressants. However, antidepressants are known to have a long list of possible side effects that can do more harm than good. Some common side effects of antidepressants include nausea, weight gain, fatigue, insomnia, and blurred vision (Robinson, 2020). As a result, researchers have started to experiment on the role of adaptogens, which are plant derived compounds, in stress management, as they are known to have stress relieving properties. While experimentation is still underway, researchers have concluded that there is “little evidence to suggest that adaptogens can cause immediate side effects” which signifies that adaptogens could be a better form of stress management treatment than antidepressants (Gannon, 2019). This paper focuses on comparing and analyzing the data of two commonly used adaptogens, ashwagandha and ginseng, in stress management using three different stress test scores. The results showed a decrease in stress levels in participants who consumed both ashwagandha and ginseng regularly. However, there were more significant decreases in stress in the group that consumed ashwagandha, which showed that ashwagandha is more effective in reducing stress levels in the body. For example, the group that consumed ginseng showed a statistically significant reduction in the Perceived Stress Score (PSS) test score of 27%. On the other hand, the group that consumed ashwagandha showed a statistically significant 41% reduction in HAM-A scores and a statistically significant 30% reduction in DASS-21 scores. These results provide insight into another possible treatment for stress management that focuses on a natural alternative to pharmaceuticals.*

*Keywords: Ashwagandha, Ginseng, Ayurvedic Medicine, Stress Relief*

## Introduction

Stress is becoming increasingly harder to manage with 44% of Americans reporting that their stress has increased over the past five years (Yaribeygi et al. 2017). There are two main categories of stress which are called internal and external stress. Internal stress is defined as the thoughts and feelings we have that may contribute, or lead, to our stress. External stress is defined as events or situations that directly affect you and cause stress. Some stress can be good for us, like when our body is preparing to face a threat. However, when our body

doesn't receive the signal to go back to normal functioning there is a buildup of stress that can lead to chronic stress (NIMH, 2018). Chronic stress interferes with the immune, digestive, cardiovascular, sleep, and reproductive systems (Yaribeygi et al. 2017). The continued strain on a person's body can lead to serious health issues such as heart disease and high blood pressure, and mental disorders such as depression or anxiety (Yaribeygi et al. 2017).

Prior studies show that there is a wide range concerning the causes of stress. Something as simple as a change in our daily routine or

a change in our diet can cause stress. In most cases the cause of stress can be determined by both the severity and the frequency of an event (NIMH, 2018). Overall, anything that affects the natural balance of hormones in our body can be defined as stress. Some of the major causes of stress include chronic illnesses, emotional turmoil, and financial responsibilities (NIMH, 2018). In terms of dealing with stress, studies show that there are mechanisms in place to help us deal with both internal and external stressors. These mechanisms are controlled by the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system and are known as the stress response (NIMH, 2018). The HPA axis is an interactive neuroendocrine unit that is in charge of releasing cortisol, which is known as the “stress hormone” as prolonged levels of cortisol have been directly linked to high stress levels. Together, the main job of the HPA axis and the sympathetic nervous system is to maintain homeostasis in the body. Homeostasis refers to the body’s ability to respond to stimuli and maintain a state of balance in the body that is essential for proper functioning (Yaribeygi et al. 2017). However, chronic stress has been linked to a dysfunctional HPA axis, meaning the human body’s natural way of dealing with stress has been damaged. The most common course of treatment for this is to administer antidepressants known as selective serotonin reuptake inhibitors (SSRIs) that work as anti-stress drugs (NIMH, 2018). However, SSRIs have an extensive list of possible side effects that include nausea, vomiting, insomnia, dizziness, and many others (NIMH, 2018).

In response to the possible side effects that SSRIs and other drugs can have on our bodies, researchers have begun to study the effects of adaptogens on stress management. Adaptogens date back to ancient Indian and Chinese civilizations and have been used in ayurvedic and other traditional medicines for their rejuvenating properties (Robinson, 2019). Adaptogens include several plants or herbs and are defined as “biologically active, medicinal

plant substances” that help your body adapt or adjust to stress (Baek et al. 2019). Studies show that adaptogens have the ability to improve the body’s nonspecific resistance to internal and external stressors, normalizing body functions, and maintaining homeostasis (Robinson, 2019). The primary effects of adaptogens include increased energy circulation, decreased perceived stress, increased resistance to stress, improved mental performance, and improved sleep (Baek et al. 2019). Each of these effects are observed with adjustment of the HPA axis, which indicates that adaptogens regulate the HPA axis pathway. Adaptogens help the body maintain homeostasis by affecting the central nervous system (CNS). They do this by targeting both biochemical markers of stress and metabolic regulators, including the hormones that regulate the HPA axis activity such as cortisol, nitric oxide, and glucose (Baek et al. 2019).

The research concerning the effects of adaptogens on stress management is still relatively new and there are many research questions that are unanswered. For example, the research that has been done has focused on how adaptogens battle adrenal fatigue, which is when our adrenal glands get overworked by stress and stop producing the hormones we need, but not much research has extended beyond that point. Significant studies on how adaptogens can affect mental performance have been overlooked, meaning they have yet to be conducted. Researchers have just recently started to explore the anti-cancer properties that certain adaptogens have. Furthermore, adaptogens tend to be considered as one group of plants and herbs, but adaptogens come in varying forms and properties. When considered separately, each adaptogen is unique, both in its physical form and its capabilities.

*Withania somnifera*, commonly known as ashwagandha, is one the most popular herbs used in traditional Indian medicine. Ashwagandha is known for its adaptogenic, antioxidant, and immune-supportive properties

(Lopresti et al. 2019). Recent studies have also shown ashwagandha to be an effective herb in weight management. Panax ginseng, commonly known as Korean ginseng, is traditionally used in Korean and Chinese medicines. Ginseng has demonstrated numerous therapeutic properties (Baek et al. 2019). Among the adaptogenic herbs, ginseng may be one of the most widely used to improve energy and general health. Ashwagandha and ginseng are the most commonly used for adaptogenic purposes, and their extracts are most commonly used.

The purpose of this paper is to compare the effectiveness of ashwagandha and ginseng in their stress-relieving properties. The data sets from two prior studies were analyzed and compared to determine if there was a substantial difference in the stress-relieving properties of ashwagandha and ginseng. The data analyzed consisted of commonly used stress test scores and questionnaires. By comparing data from similar studies with slightly varying testing scales, the effectiveness of the adaptogens can be analyzed to determine which adaptogen is better suited for stress management.

### Methods

#### Data Collection

I began my search by using PubMed to search for articles that would contribute to my research question. The first set of keywords I used were “adaptogenic”, “stress”, and “depression”. I applied the “Most Recent” filter to this particular keyword search. This search resulted in many articles, and after skimming through a few, I found a medical journal article that explained the effects of Korean Red Ginseng in individuals with high stress levels (Baek et al. 2019). I skimmed the article and determined that it was a peer-reviewed original research paper that was recently published. Using the same keywords, I found another medical journal article that detailed the stress-relieving pharmacological actions of an ashwagandha extract (Lopresti et al. 2019). After skimming

the article, I determined that it was also a peer-reviewed original research paper that was recently published. The two experiments from the journal entries were quite similar, with one being 42 days long and the other being 60 days long. Both experiments were also randomized, double-blind, and placebo controlled.

#### Data Analysis

Baek et al.’s (2019) treatment consisted of four capsules taken twice daily of either 2g/day of Korean Red Ginseng (KRG) powder or placebo for 6 weeks. The packaging, storing, and handling conditions were identical for the groups receiving both the KRG and the placebo. The normal control group received neither KRG nor placebo. Lopresti et al. ’s (2019) treatment consisted of capsules containing 240 mg of ashwagandha extract or placebo for the participants. They were instructed to take a capsule once daily after dinner with 250 mL of water. The capsules were identical in appearance, shape, color, and packaging. The experiments that Baek et al. (2019) and Lopresti et al. (2019) conducted had similar sample sizes and they met a minimum requirement I decided on. Baek et al. (2019) had a sample size of 63 and Lopresti et al. (2019) had a sample size of 60. For the purpose of my research questions, I evaluated the results of the participants that received the treatment and not the participants that received the placebo. Instead, I focused on the data taken at baseline, or day 1, and the data taken at the end of the experiment in the groups that received the treatment. The two experiments had similarities, but their results were measured on different scales. All of Baek et al.’s (2019) participants underwent the Perceived Stress Scale (PSS) test that was used to measure the degree of individually perceived stress. Lopresti et al. (2019) also conducted a clinician-administered Hamilton Anxiety Rating Scale (HAM-A) test and a self-reported Depression, Anxiety, Stress Scale-21 (DASS-21) test. Both studies also collected blood samples to assess cortisol levels in participants.

**Results**

In Baek et al. ‘s (2019) study the PSS total score at baseline was 17.52 and 14.00 at 6 weeks which indicates that the PSS test score decreased by the end of the experiment. In Lopresti et al. ‘s (2019) study the HAM-A baseline score was 10.27 and 6.07 on day 60, with a statistically significant 41% reduction in the HAM-A scores, which indicates that the HAM-A test score significantly decreased by the end of the experiment. The DASS-21 baseline score was 16.83 and 11.77 on day 60, with a statis-

tically significant 30% reduction in DASS-21 scores, which indicates that the DASS-21 test score decreased by the end of the experiment. A comparison of Baek et al. ‘s (2019) and Lopresti et al. ‘s (2019) studies that show the decrease in PSS, HAM-A, and DASS-21 scores at baseline and at the end of their experiments can be seen in figure 1. This [figure 1] indicates that the participants in both Baek et al. ‘s (2019) study and Lopresti et al. ‘s (2019) study all showed a decrease in stress, depression, and anxiety after consuming adaptogens in either a powder form or a capsule for a set amount of time.

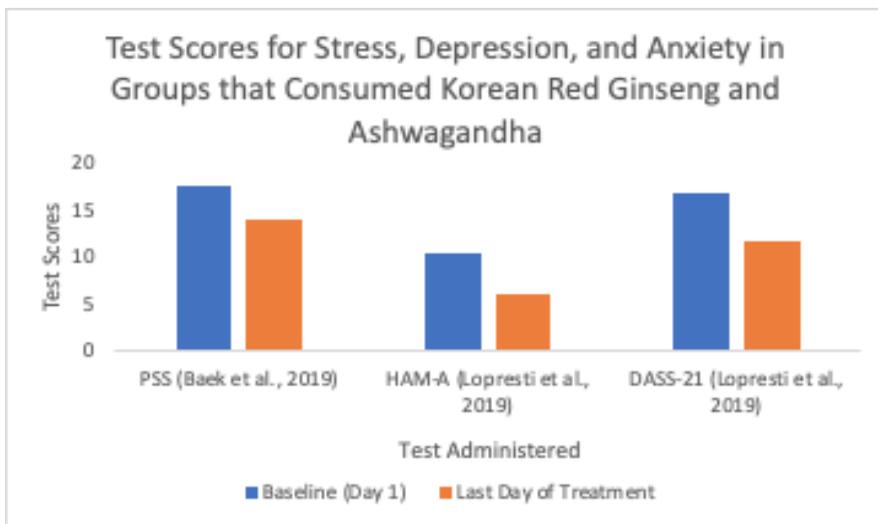


Figure 1: This graph compares the PSS test score that were administered in Baek et al. ‘s (2019) study with the HAM-A and DASS-21 test scores that were administered in Lopresti et al. ‘s (2019) study. The graph shows the test scores at baseline, meaning day 1, and at the end of the two experiments.

**Discussion**

This study used data collected from two previous studies (Baek et al. 2019 and Lopresti et al. 2019) to compare the efficiency of two well-known adaptogens, ashwagandha and ginseng, to show that both helped to decrease stress at similar rates. Furthermore, the results indicated that both adaptogens had very similar effects on stress levels; however Lopresti et al. ‘s (2019) experimental group that consumed ashwagandha showed slightly higher scores than the ginseng experimental group from Baek et al. ‘s (2019) study. For example, Baek et al. ‘s (2019) study showed a statistically significant 27% reduction in PSS scores at the end of the

study. Lopresti et al. ‘s (2019) study showed a statistically significant 41% reduction in HAM-A scores and a statistically significant 30% reduction in DASS-21 scores. These findings are significant because they can provide insight into different forms of medication for stress for patients who either can’t be prescribed pharmaceuticals due to potential complications or who would rather manage their stress using a natural alternative. Furthermore, throughout the research that was conducted for my experimental question, I was unable to find a scientific paper or journal that compared the stress relieving capabilities of ginseng and ashwagandha.

In Baek et al. 's (2019) study, the results confirm that consuming ginseng regularly has positive effects on reducing stress levels, as well as depressive symptoms. The study also found a correlation between consuming Korean Red Ginseng and a stabilization within the central nervous system, autonomic nervous system, and hypothalamic-pituitary-adrenal axis. Lopresti et al. 's (2019) study had a correlation of a 41% reduction in stress and anxiety in participants consuming ashwagandha versus a 24% reduction in participants consuming a placebo. Overall, both studies showed an overall decrease in PSS, HAM-A, and DASS-21 scores.

Both of these adaptogens are relatively more common than others because of their average low cost and their accessibility (Robinson, 2019). Furthermore, this paper includes a broad range of tests that were conducted to measure the degree of individually perceived stress. For example, Baek et al. 's (2019) study measures each participant's perceived stress using the PSS test, while Lopresti et al. (2019) used both the HAM-A and DASS-21 test. This shows the results of both studies in terms of three different widely used perceived stress scales.

As mentioned earlier, there are not many research studies comparing adaptogens to each other. However, there have been studies conducted on specific adaptogens and their potential benefits. For example, a study was conducted that found that consuming ashwagandha on a regular basis acted as a treatment for depression and anxiety for people with schizophrenia (Gannon, 2019). Another study was conducted that looked at how the adaptogen, rhodiola, affected eating compulsions in obese women. Their results did show a reduction in mean weight and BMI, but the data was not statistically significant (Da Silva et al., 2018). Both the Gannon (2019) and the Da Silva et al. (2018) studies had mild and transient side effects.

One limitation of this study was the very few scientific articles available that compare the efficacies of adaptogens to each other. Another limitation of this study was how relatively new adaptogens are. Most of the data in scientific journals concerning adaptogens is new and there is very little data taken over a long period of time. One limitation from the studies involved in this paper worth noting is that the participants' perceived stress levels were measured using different tests. Baek et al. 's (2019) study used the PSS test and Lopresti et al. 's (2019) study used the HAM-A and DASS-21 tests. Due to the limited time scope of both experiments, it is important to note that the results from this paper should not be considered as a lone piece of evidence.

While the results of this paper show the benefits that consuming ashwagandha and ginseng have on stress management, more research can be done on adaptogens themselves. For example, there are very few experiments that have been done on the long-term effects of consuming adaptogens regularly. While the short-term effects are positive, the long-term effects can have vastly different effects on the body. Another question that can be answered is how stress can be affected by the administration of more than one adaptogen at a time. This can also include research on whether adaptogens target specific ailments or if they work as general relievers. Overall, this paper contributes to scientific literature and research because it contributes to existing research concerning more natural alternatives to stress, anxiety, and depression management.

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# THE PRICE OF OIL: ISSUES IN THE OIL RICH NIGER DELTA

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*ABSTRACT: This paper aims to shed light on the issues occurring in the Niger Delta and provide policy recommendations for the U.S. and Nigerian governments to help address the human rights violations occurring. The Niger Delta is rich in oil and has a long history of exploitation from the fossil fuel industry. A byproduct of this exploitation is the inhuman treatment of the locals in the Delta and extensive environmental damage. Multiple research papers about the Niger Delta have highlighted the faults in managing the exploitation and extraction of oil by the fossil fuel industry and government. As a direct result, thousands of Niger Delta communities have had their human rights violated, such as their right to life, health, the safeguard of land, air, water, and wildlife. Multiple militant groups have sprung up due to the lack of governmental intervention, leading to violence and disruption in the area. My findings indicate that the issues in the Niger Delta are a result of the lack of governmental control over how fossil fuel industries, such as Shell, are allowed to operate in the area. I recommend that the U.S. reassess its support in Nigeria to ensure that human rights violations cease and adequate aid be provided to the economy. The Nigerian government needs to revisit its Constitution, human rights, and policy documents to hold companies accountable and do due diligence for the people.*

## Introduction

The systemic destruction in the Niger Delta from the petroleum industry and the negligence of the government have given birth to multiple militant groups who try to defend their land, people, and lives. Their corrupt government and oil companies have deliberately ignored the grievances of those people devastated by oil, causing the people's land, air, water, and lives to be drenched in oil. The main perpetrator is Shell Petroleum Development Company who has executed violence upon different Delta communities. The Nigerian government turns a blind eye to their violence to protect their assets. The ongoing humanitarian crisis surrounding the Boko Haram terrorist group has deflected attention away from the root cause of the Niger Delta issues, a negligent corporation and corrupt government that together have wrecked the local environment and people.

This paper will explore the issue of the Niger Delta through a human rights lens, addressing and analyzing the different ways the

Delta communities are affected by oil and the government's leading role in the discussion. A summary explaining the history of oil exploration and Nigeria's military governance will help shed light on why this is an ongoing problem. I will discuss the human rights abuses regarding oil spills and gas flaring, two case studies showing the grievances and abuses occurring in the Delta even with democratic governance. The formation of militant groups will show the aftermath of protests, massacres, and lack of responsibility for these issues. Finally, the United States stake within this issue will also be examined, and policy recommendations to help address the problems occurring in the Niger Delta will be put forward.

## The Niger Delta: Nigeria's Hub for Oil Exploitation

The Niger Delta refers to the southern region of Nigeria, consisting of Cross River, Akwa Ibom, Rivers, Bayelsa, Delta, and Edo States (Asuni, 2009). It is the region's coastal area, containing freshwater and mangrove swamps,

beach ridges, sand bars, lagoon marshes, and tidal channels (Adati, 2012). Oil exploitation has devastated the surrounding environment and disrupted the livelihood of those who depend on the ecosystem for survival (Adati, 2012). Unsustainable oil exploration has contributed to the Niger Delta being one of the world's top five severely damaged ecosystems by petroleum (Adati, 2012). Due to the mismanagement of pipelines and installation, there have been large areas of forests and mangrove swamps that have been cleared, resulting in habitat loss.

Nigeria is Africa's most populous country and largest oil producer, with the Niger Delta supplying the resources for oil exploitation (Asuni, 2009). The Nigerian government obtains most of its oil from different basins within the Niger Delta. Oil revenues contribute to 90% of Nigeria's foreign exchange earnings and 85% of public and governmental revenues since 1970 (Ukiwo, 2020). Production and export levels have averaged between 1.2 to 1.7 billion barrels per day over the past decade (Ukiwo, 2020). Unfortunately, the government's lack of political stability and corruption has led to communities in this area receiving little benefit from oil shares (Asuni, 2009).

## **Exploration of Oil in Nigeria**

The growth of fossil fuels has shaped the world's energy sector since its discovery in 1859 (Adati, 2012). Following the discovery of oil, multinational oil companies began to spread rapidly to countries to explore and exploit oil. Exploration opportunities in Nigeria started in 1907 by the Nigerian Bitumen Corporation (Ukiwo, 2020). In 1956, Shell Petroleum discovered oil in Oloibiri, a village in the modern-day Bayelsa state (Adati, 2012). By 1958, Nigeria produced and exported 5,100 barrels of oil per day (Ukiwo, 2020).

With the oil sector booming in the state, the government wanted to control the distribution of all oil revenues and resource shares, specifically on a local government level. Before

the Petroleum Act, a 50-50 split benefitted the federal government and state, but the Act decreased state shares to 45% (Ukiwo, 2020). The Federal Military Government further slashed allocations to states based on derivation from 35% to 20% in 1975 (Ukiwo, 2020). In 1982, a revised revenue allocation provided that 1.5% of revenues would be shared based on derivation to the communities. By 1990, the Niger Delta states' share of oil revenues was just 1%, which stimulated the rise of movements for the autonomy of the Niger Delta and the resentment of government and oil companies in oil-producing communities (Ukiwo, 2020). The Oil Minerals Producing Areas Commission (OMPADEC) was established in 1993, which "endowed 3% of oil revenues to address the ecological, social, and economic challenges of the region" (Ukiwo, 2020). However, this Commission did not satisfy the people's wish for autonomy or increase benefits significantly to oil-bearing communities.

## **The Nigerian Government's Military Regimes**

A review of Nigeria's military regimes is necessary to understand the state's instability and corruption. Since its independence from British rule in 1960, Nigeria has been through numerous military coups, with periods of democratic rulings (Asuni, 2009). Military power lasted from 1966 until the Second Republic began in 1979. Since then, four different military regimes had taken over, each overthrowing the next regime with the promise to restore representation and power to the public. It wasn't until 1999 when elections took place and the Fourth Republic with Olusegun Obasanjo was instated, and Nigeria's Constitution of 1999 was created. Since 1999, democracy has been in place with Buhari, a former military regime ruler, as the current president.

## **Issues in the Niger Delta/ Stakeholders**

The Nigerian government is the main stakeholder in this issue as they control oil

resources in the Niger Delta. They issue licenses to companies, regulate exploitation, distribution, and oil revenues that should go back to the Niger Delta to develop schools, roads, and bridges (Ojatorotu 2018). Unfortunately, the government has prioritized the elites' financial stability over the populace of the Niger Delta living under extreme hardship (Ojatorotu 2018). Trillions of dollars accumulated from the oil industry have reportedly been used to support elite consumption (Ukiwo, 2020). The government controls what happens with oil, making them the most influential stakeholder in this issue and responsible for protecting their citizens.

Multinational oil companies, specifically Shell, have directly impacted the Niger Delta communities by disregarding oil spills and gas flaring laws, which have led to soil, water, and air pollution. This has affected the Niger Delta residents' farming and fishing activities and their inability to sustain their community. Shell claims they "promote trust and openness" and "takes pride in what we do and how we conduct business" (Shell, 2019). However, the reality is that their immense power in the region (controlling 40% of all oil production in ND) adversely affects the people of the Niger Delta. Multinational oil companies' activities have created violent militant groups who oppose them and retaliate through sabotage and vandalism of oil facilities and installations.

Militants, such as the Movement for the Emancipation of the Niger Delta (MEND) and The Niger Delta Avengers (NDA), take a stake because they are fighting for reasonable shares of petroleum profits from the government (Ade, 2019). They originate from oil-bearing communities that face food and water shortages, environmental damages, and a lack of economic development (Kastoan, 2020). These militant groups demand reasonable shares of oil revenues from the government to ensure the people of the Niger Delta live in clean, habitable areas and control what happens to the oil in their land

(Kastoan, 2020). They have moderate power because they can inflict damage on the economy by their actions, but they cannot make policy decisions.

The Niger Delta communities such as the Ogoni, Odi, and other communities are affected by the Nigerian government and multinational oil corporations (Toboni, 2018). These communities suffer from oil spills, pollution, and decreased food and water supply imposed by oil companies. Oil corporations, specifically Shell, have directly supported violent acts on communities' members by massacring, raping, and destroying villages in the name of oil profits. The Nigerian government's failed implementation of policies to address their grievances has left communities suffering. Communities are also affected by militant attacks on oil installations since their attacks increase pollution and the environmental tragedy in the Niger Delta (Asuni, 2009). They hold the least power, especially when tensions grow between them and oil companies.

## **Willful Negligence of the Nigerian Government and Shell Petroleum Company Oil Spills**

Tensions between the government's policies around oil and its effects on minority groups arose during the military era in the 1990s (Ojatorotu, 2018). The government pressured oil corporations to maximize oil production, leading many IOCs to operate unregulated (Onwuazombe, 2017). In the past 50 years, 9 million to 13 million tons of oil have been spilled in the Niger Delta (Onwuazombe, 2017). Shell's Forcados 6 tank in the Delta state spilled 570,000 barrels of oil into the Forcados estuary, polluting aquatic and terrestrial ecosystems (Adati, 2012). In the 1980s, Chevron's Funiwa No. 5 well blew 421,000 barrels of oil into the ocean and destroyed 836 areas of mangrove forests in its path (Adati, 2012). Shell Petroleum Development Company had also reported 221 spills per year since 1989 (Adati, 2012).

Within 20 years, 2,369,470 barrels of oil were spilled into the environment. Most of these spills in the Niger Delta have occurred due to pipeline and storage facilities failures, but big oil companies blame sabotage, vandalism, and illegal refineries (Adati, 2012). After years of oil spills, no recovery has occurred, and the Niger Delta is left drenched in oil (Adati, 2012).

In Bodo, a community in the River State, fishing and farming were dominant occupations for the residents, with Bodo recognized once as “the fish basket of Gokana”. The fish-farming and harvesting industry employed tens of thousands of people in Bodo (Pegg, 2013). However, from August 28th, 2008 to November 7th, 2008, Shell’s 55-year-old pipeline spilled more than 600,000 barrels into surrounding water basins (Morgan, 2017). Another spill occurred on December 7th, 2008, and lasted until February 21st, 2009 (Morgan, 2017). These two massive oil spills leaked into rivers and creeks, killing fish and eliminating people’s source of food and income (Uwemedimo, 2018). Article 3a of Nigeria’s Constitution of 1999 states that “all citizens, without discrimination on any group whatsoever, have the opportunity for securing adequate means of livelihood as well as adequate opportunity to secure suitable employment” (Nigeria, 1999). However, due to these oil spills, thousands of people lost their jobs, and employer’s fishing areas were devastated by oil (Pegg, 2013). Although the petroleum industry is a primary employment source for foreign workers in the Niger Delta, local farmers and fishermen lack opportunities because of pollution. Fishermen in the Bodo community cannot find suitable work due to the decline in fish stocks, and most of the oil industry in the Niger Delta is taken by foreign workers. Fishermen today are forced to illegally refine oil as a source of income, which will be discussed further.

The Bodo residents have also had their right to health taken away due to government and Shell’s willful negligence. The African Charter

on Human and Peoples’ Rights (ACHPR) clearly states in Article 16 that “every individual shall have the right to enjoy the best attainable state of physical and mental health” and “State Parties to the present Charter shall take necessary measures to protect the health of their people” (ACHPR, 1981). Article 20 of the 1999 Constitution notes that “the State shall protect and improve the environment and safeguard the water, air, land, forest, and wildlife of Nigeria” (Nigeria, 1999). However, the residents’ health declined by drinking water with hydrocarbon concentrations far exceeding the Nigerian drinking water standards (Pegg, 2013). The residents continued to use the water for “drinking, bathing, washing and cooking because there was no alternative” (Pegg, 2013). Their water, air, land, and forest have not been protected, with 836 acres of mangrove trees destroyed, ultimately decreasing the communities’ access to firewood and disturbing Nigeria’s natural wildlife (Adati, 2012).

Cleaning up oil spills in the Niger Delta has been a slow process, regardless of regulations and laws to ensure clean up. The National Oil Spill Detection and Response, which reports and detects oil spills, took more than 70 days to address and stop the spills. This reluctance to respond to oil spills promptly and to hold Shell accountable violates Nigeria’s National Oil Spill Detection and Response Agency Act, which states:

the failure to clean up the impacted site, to all practical extent including an action plan for remediation within two weeks of the occurrence of the spill... Shall constitute an offense and on conviction the oil spiller shall be liable to a fine not exceeding 5,000,000 Naira or to imprisonment for a term not exceeding 2 years (National, 2006).

To summarize, the government’s lack of action to hold companies such as Shell accountable for unlawful business practices has directly impacted the very people they have pledged to protect.

Members of the Bodo in the River State sued Shell in 2012, seeking compensation for the two oil spills and the loss of their health, land, and livelihoods (Business, 2018). They requested a cleanup of oil pollution, and in 2015, Shell agreed to an \$84 million (US dollar) settlement to help pay for cleanup and pay each community member \$3,300 (Business, 2018). However, Shell's efforts in addressing environmental issues have been inefficient (Maiangwa, 2013). Before cleanup was due to start, they tried to strike out of the lawsuit in 2017, asserting that some community members obstructed cleanup (Business, 2018). They later attempted to block the Bodo community from going back to court by including a clause to "which any disruptive act by any resident of the Bodo community would lead to termination of the lawsuit" (Business, 2018). Despite the judge's ruling that Shell was still responsible for spills from their pipelines, Shell did not conduct an adequate clean-up, leaving the ecosystem to remain vulnerable, and poverty continues to increase despite payouts (Maiangwa, 2013). When oil spills are cleaned up, they are noticeably insufficient, with "the difference between a cleaned-up site and a site awaiting cleanup was not always obvious" (Pegg, 2013). Furthermore, according to Amnesty, Shell has claimed to have cleaned up multiple sites, but visits to said sites have recorded oil still encrusted into the land decades since spills (Uwemedimo, 2015).

## Gas Flaring

Another prominent issue that occurs regularly in the Niger Delta is gas flaring (Adati, 2012). Gas flaring is a process where Associated Gas (AG) is separated from methane, natural gas (Ejiogu, 2013). To obtain the methane, it either needs to be stored, re-injected into the reservoir, or flared or burned when AG cannot be easily captured (Ejiogu, 2013). According to Article 2d in the 1999 Constitution of Nigeria, gas flaring violates residents' human rights, which states, "The State shall direct its policy towards ensuring: that suitable and adequate

shelter, suitable and adequate food... are provided for all citizens" (Nigeria, 1999). In 2004, there were 123 gas flaring sites in the region, emitting temperatures that negatively impact the environment, arable land, and human life (Adati, 2012). Gas flaring affected numerous communities' food supply, with 45.8 billion kilowatts of heat discharged into the atmosphere from gas flaring, rendering large areas inhabitable (Adati, 2012). This heat kills surrounding vegetation and mangrove swamps and diminishes agriculture production and soil nutrition (Adati, 2012). A study found that there was a direct relationship between gas flaring and the decline in agricultural productivity—with a flaring site 200 meters from farmland resulting in 100% yield crop loss, 600 meters with a 45% reduction, and 1 kilometer having 10% crop loss (Adati, 2012).

In addition to crop yield loss, gas flaring produces greenhouse gasses methane and carbon dioxide, affecting climate globally and directly impact community members in the Niger Delta (Ejiogu, 2013). As noted in Article 21 of the African Charter, "all peoples shall have the right to a general satisfactory environment favorable to their development" (ACHPR, 1981). Yet, flaring releases 250 toxins is present in the atmosphere within 15 kilometers of the flare site and has attributed to acid rain and augmented concentration of heavy metals in surface and groundwater, ultimately poisoning water supplies that community inhabitants drink (Ejiogu, 2013).

In 2005, Jonah Gbemre and the Iwheroken community in the Delta State sued Shell Petroleum Company of Nigeria, Ltd, NNPC, and the Attorney General of the Federation, claiming that gas flaring violated their human rights (Onwuazombe, 2017). The plaintiffs argued that gas flaring had violated Sections 33 (1) and 34 (1) of the 1999 Constitution, Articles 4, 16, and 24 of the African Charter, their rights to life and dignity. They argued that the company's continuous gas flaring had led to poisoning and

pollution of the environment, which exposed residents to various health risks (Amao, 2008). It was reported that the residents complained of respiratory problems such as asthma and bronchitis and other illnesses such as cancer (Amao, 2008). When residents were exposed to long-term pollutants, nausea, cardio-vascular failure, lung injury, cancer, and autoimmune rheumatic disease were also reported (Ejiogu, 2013). The Iwhereken community argued that the Associated Gas Re-Injection Act, which allowed the continuance of flaring regardless of illegality in 1984, was inconsistent with the Constitution's right to life (Onwuazombe, 2017). The judge ruled that the Attorney General of the Federation needed to amend legislation to align with the Constitution, that Shell did violate their human right to clean, poison-free, pollution-free environment, and their right to life and dignity (Amao, 2008).

Since *Gbemre v. Shell*, Shell and other international companies have continued to flare, regardless of laws prohibiting it (Onwuazombe, 2017). The government receives a large sum of income from foreign exchange earnings, resulting in relaxed enforcement of the 1984 flare deadline (Ejiogu, 2013). The Associated Gas Re-Injection Act loophole allowed the Minister of Petroleum to authorize which companies could flare gas (Ejiogu, 2013), and today 84% of total gas is still flared (Adati, 2012)

## **Case Study- Rivers, Bayelsa, and Overlooked Delta Communities**

### **River State- Ogoniland**

The Ogoni people are a community located in the southeast region of the Niger Delta, in the River State (United Nations, 2011). Numerous oil companies, including Shell, have been exploiting oil since the late 1950s, which has polluted land, water, and the air, which has threatened the Ogoni's livelihoods (United Nations, 2011). In 1958, Shell identified an oil field on the Delta and began to extract oil, resulting in a 15-year period where thousands of

oil spills occurred in Ogoniland (United Nations, 2011). These oil spills impact the Ogoni's human rights to standard living and adequate health. Article 25 of The Universal Declaration of Human Rights (UDHR) claims "everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing, and medical care and necessary social services" (UDHR, 1948). Traditional farming and fishing were rendered impossible due to the amount of pollution, and groundwater is still contaminated today, posing a threat to the health of the Ogoni (United Nations, 2011). These people's rights to clean water, farming, and clean air have been taken away by both the government and Shell's lack of interest in supporting the local community by honoring laws designed to protect the people. The Council of Ogoni Traditional Rulers revealed that the negligence of the government has led to "thousands of children in the community to be suffering from cancer and other deadly diseases from exposure to contaminated air, water and food from oil spills and gas flaring in the area" (Onwuazombe, 2017).

The apparent blatant negligence on behalf of the Nigerian government led to the creation of the Movement for the Survival of Ogoni People (MOSOP), which is an organization set up to defend the environment and human rights of the Ogoni in the Niger Delta (Ken, 2012). The MOSOP was established by Ken Saro-Wiwa, an environmental activist and famous Nigerian author who criticized the government's oil policies (United Nations, 2011). The organization practiced peaceful protests, with 300,000 Ogoni marching and campaigning for greater control of oil resources and greater political autonomy (United Nations, 2011). These protests led to oil production activities in Ogoniland ceasing in 1993 (United Nations, 2011). In a leaked governmental memo in May 1994, "the ruling military regime had detailed wasting operations to eliminate vocal Ogoni leaders. The wasting operations were deemed necessary to ensure the

resumption of an oil-drilling operation in the Ogoni” (Onwuazombe, 2017). Less than two weeks after the memo, Saro-Wiwa was taken from his home and jailed due to the connection of inciting youth to murder four Ogoni leaders (Ken, 2012). In November 1995, a trial by a military tribunal executed Saro-Wiwa and eight other Ogoni leaders, increasing protests and captured international attention (United Nations, 2011).

The Ogoni faced numerous human rights violations, especially their right to life. Article 4 of the African Charter states, “Human beings and inviolable. Every human being shall be entitled to respect for his life and the integrity of his person. No one may be arbitrarily deprived of this right” (ACHPR, 1981) and Article 3 of the UDHR says “everyone has the right to life, liberty and security of person” (UDHR, 1948) as well as the ICCPR: “Every human being has the inherent right to life. This right shall be protected by law. No one shall be arbitrarily deprived of his life.” (ICCPR, 1976). Yet, sections and chapters of these documents are merely ornamental and halfheartedly implemented and ineffective for the Ogoni people. The Nigerian government has deprived and undermined the Ogoni’s right to life by killing 132 Ogoni men, women, and children returning from a trip to the Cameroons (Onwuazombe, 2017). In 1993, the Ogoni village of Kaa was stormed by government troops using grenades, mortar shells, and automatic weapons, slaughtering more than 247 unarmed civilians (Onwuazombe, 2017). The government has failed to protect their people’s security by letting Shell fund the Nigerian military to silence the Ogoni leaders and members of the MOSOP (United Nations, 2011). The Nigerian government’s termination of Ken Saro-Wiwa and the eight other Ogoni leaders violated their right to life by execution. They were not protected by the law and instead were killed by the federal government for alleged crimes. Although the death penalty is legal in Nigeria, these executions of the Ogoni Nine lead to Nigeria being treated as

a pariah state, temporary expulsion from the Commonwealth, and provoking international outrage (Onwuazombe, 2017).

Currently, Shell no longer operates within the Ogoni community, but their pipelines cross Ogoniland and still burst upstream, leading to downstream pollution, impacting the Ogoni people (Toboni, 2018). Ogoniland’s ground is covered in oil and destroyed to the point where nothing can grow, and a thick, black clay covers the earth (Toboni, 2018).

## **Bayelsa State- Odi Massacre**

On November 4th, 1999, an armed gang killed seven Nigerian police officers in Odi, the Bayelsa State of the Niger Delta (Human Rights Watch, 2019). Five more police were killed in the following days. These killings were committed by a group living in the oil-producing areas (Human Rights Watch, 2019). President Obasanjo gave two weeks for those who killed police to come forward, or he would declare a state of emergency. Before the deadline, the Nigerian military moved in on Odi, killing 2,000 innocent civilians and destroying housing and infrastructures to protect oil operations (Human Rights Watch, 2019). This act of genocide violates the ICCPR Article 6.3, “When deprivation of life constitutes the crime of genocide, it is understood that nothing in this article shall authorize any State Party to the present Covenant to derogate in any way from any obligation assumed under the provisions of the Convention on the Prevention and Punishment of the Crime of Genocide,” as well as the cruel, inhuman and degrading punishment articles mentioned in the UDHR and 1999 Constitution. The Nigerian military “razed the community in retaliation for the death of 12 policemen deployed to protect oil facilities” (Onwuazombe, 2017) and destroyed buildings, banks, churches, and hospitals (Courson, 2006). It was also reported that the gang who was responsible fled while their people were massacred (Human Rights Watch,

2019). A presidential spokesman skeptically described the massacre as “a carefully planned and cautiously executed exercise to rid the society of these criminals” (Onwuazombe, 2017). The army targeted the Odi people, not just the criminals, killing thousands of people and destroying infrastructures in the name of protecting oil assets.

The Crimes Against Humanity, War Crimes, Genocide and Related Offences Bill in 2012 also elaborates that “a person who, in Nigeria or elsewhere- commits genocide or conspires or agrees with any person to commit genocide, whether that genocide is to be committed in Nigeria or elsewhere, commits, and offence and is liable on conviction, to the penalty specified...” (Crimes, 2012). These penalties include “imprisonment for a term not exceeding 30 years or a term of life imprisonment when justified by the extreme gravity of the offence and the individual circumstances of the convicted person” (Crimes, 2012). This bill was the outcome of a new democratic government to pass war crimes. However, numerous human rights documents discussed genocide, cruel and unusual punishment as intolerable before this Bill was passed in 2012. The government and the international community overlooked the Odi massacre, and those who inflicted violence were not held accountable.

The government denied the Odi massacre allegations, and security forces who carried out the violence have not been held accountable (Onwuazombe, 2017). The government awarded ₦37.6 billion (US\$98,635.88) for the damages despite denials, and those who executed the genocide were reported to have been promoted (Onwuazombe, 2017).

## **Overlooked Massacres in the Niger Delta**

These cases are not the only examples of massacres and acts of violence against the Niger Delta communities in oil-producing areas. The community of Odioma was invaded and razed to the ground in February 2005 by a military task

force (Courson, 2006). Disputes over ownership of land between different Ijaw communities, who are a minority group in Nigeria, interrupted Shell’s ability to install oil pipelines and refineries on the land (Amnesty, 2005). The task force in the region was stationed to arrest, kill, or ruthlessly deal with those tied with criminal activities against the oil industry in the Niger Delta (Courson, 2006). In retaliation to the armed members’ suspected killings of four local councilors and eight others earlier that month, the task force killed 17 Odioma civilians and raped numerous women (Amnesty, 2005). Eighty percent of homes were destroyed, and among those dead, a 105-year-old elder and 2-year-old were burned to death (Amnesty, 2005). Rulers of Odioma were “whipped and forced to eat sand, amounting to torture and cruel, inhuman and degrading treatment” (Amnesty, 2005). It was also reported that members of the task force police were hired by Shell to disperse those who were a part of the Odioma community (Amnesty, 2005).

Another community was devastated by oil-related activities. Yenogua and Kaiama, the two largest Ijaw-dominated towns in Bayelsa’s oil state, were attacked by the military in December 1998 and January 1999 (Amnesty, 2005). This came after youth Ijaw formed a declaration demanding “self-government and control of resources for the Ijaw people within a federation of ethnic minorities” (Amnesty, 2005). The Ijaw youths gave the government until December 31st, 1998, to respond to the demands or risk having the oil companies stationed in Ijawland sabotaged. The military mobilized and hunted, arrested and incarcerated leaders, and cracked down on protests (Amnesty, 2005). Several special military task force teams have attacked many Ijaw communities “in the name of combating anti-oil militias, destroying houses and killing hundreds of people” (Amnesty, 2005). These disputes led to the Umuechem massacre of 1990 in the Rivers state, where heavily armed police officers shot and killed over 80 people and set ablaze 500 of the villager’s houses

(Onwuazombe, 2017). A judicial commission, which the government set up to investigate the causes of this massacre, “found not a single thread of evidence of a threat of violence on the part of the villagers” and censured police involvement (Onwuazombe, 2017). No one was held accountable.

## **Formation of Militant Groups in the Niger Delta**

With the increase in environmental damages, the eruption of violence in Delta communities, and the government’s inability to use oil revenues to transform people’s lives, different militants and mobilization began to rise (Ukiwo, 2020). The Oil Minerals Producing Areas Commission in 1993 gave 3% of oil revenues to address the social, economic, and ecological problems occurring in the Niger Delta (Ukiwo, 2020). However, this didn’t address autonomy or the reduction of oil revenue controls in the state governments, so protests grew throughout the late 1990s (Ukiwo, 2020). These protests stemmed from the decreased percentage of revenues for minority groups and the lack of employment in the oil industry that favored foreign workers and the ethnic majority groups in Nigeria (Ukiwo, 2020). Soon, the Niger Delta people took action to stop the production of oil, and the increase of militancy in the region began (Ukiwo, 2020).

The Movement for the Emancipation of the Niger Delta (MEND) formed in 2006, becoming one of the largest militant groups in the Niger Delta. MEND is a continuously changing mass of groups with the sole purpose of using military force to attack infrastructures (Asuni, 2009). By 2007, more than 25,000 members were involved; however, others have estimated up to 60,000 (Asuni, 2009). Each militant had differing characteristics and motivations for joining the newly formed group. Most were between the ages of 20-39 and economically powerless (Asuni, 2009). They had a common desire to join to protect their land, community, and ethnic

group and protest against the government and oil companies (Asuni, 2009). There was also a common desire to make money through criminal activities, such as oil bunkering, which was the only source of income for some (Asuni, 2009).

Collectively, MEND argued that poverty, environmental destruction, and governmental corruption affect their livelihoods, which they used to legitimize their violence towards oil companies (Dakar, 2016). They demanded improvements of conditions in the region, local control over oil resources revenues, and economic development for the Niger Delta people (Kastoan, 2020). Alongside these demands were jobs for rural communities, contracts, oil licenses, and autonomy from Nigeria (Dakar, 2016). Their first attack was in 2006, where the militants targeted petroleum companies by kidnapping foreign workers and damaging refineries and pipelines (Ade, 2019), which increased petroleum prices around the world (Asuni, 2009). Other activities included car bombing and oil bunkering to meet their objective (Kastoan, 2020). During this year, the Nigerian government’s goal to import 4 million barrels by 2010 was impacted due to these attacks, which forced oil production to shut down up to 800,000 barrels per day (Dakar, 2016).

It wasn’t until 2007 when the government established the Presidential Amnesty Program (PAP), which was a locally funded, designed, and implemented Demobilization, Rehabilitation, and Reintegration (DDR) program (Ebiede, 2020). The amnesty program was intended to demobilize, rehabilitate, and reintegrate ex-militants who disarmed voluntarily (Ebiede, 2020). The program provided counseling and training for ex-militants to help prepare them for reintegration into civilian life (12). By 2008, 30,000 militants surrendered their weapons, and 15,459 registered for the PAP, each receiving a stipend of ₦65,000 (US\$400) during their integration phase (12). The militants were able to train in a wide range of fields, such as

agriculture, welding, oil and gas technology, heavy-duty operations, law, and business (Ebiede, 2020). This program successfully addressed the security situation in the Niger Delta as the attacks against oil infrastructures ceased and kidnapping declined (Ebiede, 2020). These elements helped the production of oil increase, with oil production reaching 2.5 million barrels a day in 2012 due to the program, which generated more revenue for Nigeria (Ebiede, 2020).

There were many shortcomings in this program. It came at a considerable expense to the government, with ₦200 billion (US\$1.68 billion) annually towards paying militants (Matt, 2016). The training programs did not reflect the demands of local employment opportunities since most jobs were within the oil sector and not within the program's disciplines (Ebiede, 2020). For example, the training would include agriculture, welding, oil and gas technology, heavy-duty operations, law, and business disciplines, but a large portion of jobs in the Delta are within the oil industry. In the aftermath, only 200 out of the 15,459 registered PAP militants were able to find employment between 2010-2012, leaving many in poverty and more resentful (Ebiede, 2020). Contractors, who received reimbursement for every ex-militant they had in their training, would abuse funds by inflating the number of militants enrolled and collect payment despite no training (Ebiede, 2020). These payments did not address the Delta's environmental tragedy, multinational corporations' negligence, or the continuing human rights abuses. The PAP also failed to address the inadequate access to employment, the Niger Delta communities' wellbeing, and fair shares of oil revenues. To make matters worse, when the decrease in the price of oil in 2009 occurred, the government had a hard time funding the PAP and many militants were either paid late or not at all, and, as a result, 2,000 PAP participants had to quit their training before completion (Ebiede, 2020).

When Buhari announced a 70% decrease, the Niger Delta Avengers, a new militant group, emerged and attacked offshore pipelines in the deep waters off the coast (Ebiede, 2020). The PAP directly supplied valuable skills to target the oil industry, with ex-militants who were a part of the PAP's underwater diving training and welding program carrying out attacks (Ebiede, 2020). This new emergence of militants has the same objectives as MEND, but also to deteriorate oil production and establish an independent, sovereign Niger Delta state (Abutu, 2017). They also demanded a larger portion of state resource revenues but through positions in the federal government or amnesty payments (Matt, 2016). The NDA launched its bombing campaign in 2016 to cripple the Nigerian economy (Matt, 2016). They bombed Chevron installations, followed by other major multinational corporations in the region, such as NNPC, Agip, and Shell (Abutu, 2017). The rebel's attacks reduced oil production by over 1 million barrels a day in 2016, the lowest it had been in 25 years causing Nigeria to fall into a recession (Ebiede, 2020).

The black market of illegal refineries and oil in the Niger Delta emerged due to militant oil-thieves (Ralby, 2017). Gianna Toboni, a producer and correspondent at VICE News Tonight, traveled to the Niger Delta to experience firsthand the raging battle over oil control (Toboni, 2018). She was able to access illegal oil refineries buried within the creeks of the Niger Delta with the protection of a few men from the NDA and oil businessman (Toboni, 2018). When she stepped out of the boat, she described how "everything is burnt to the ground, this entire town... the smell of oil here is overwhelming, everything is rotting, and everything is covered in oil" (Toboni, 2018). Within these refineries, oil thieves pump stolen oil from ships, store and "cook" and refine the oil in ovens, where it is cool and pumped into the reservoir, ready to be exported and go on the market (Toboni, 2018). At night, the residents pour waste into the oven from the oil production process and flare so the

lightest of all the products, gasoline, is leftover with other chemicals that will be disposed of (Toboni, 2018).

The Nigerian military destroys these illegal refineries, slashing barrels and bags of oil, and dumps them onto the ground, where it flows into their waterways. The commandant of the military raid says that the oil from these illegal refineries is substandard; its “more dangerous when you take it out of this place, if it goes to the local market and society, it gets put into vehicles, and it is not good for society, so it is destroyed here” (Toboni, 2018).

Oil is central to rural communities’ livelihood, with many participating in illegal oil refining within their village (Toboni, 2018). Fishermen, in particular, turned to illegal refining due to the lack of fish in the community. Many do not want to participate in this work, but one resident explains that “I don’t have any other work. I survive with this little work that I am doing illegally... this is just how our people survive” (Toboni, 2018). Another resident explains that “what you see here is just a means of survival. We are fighting to eat! The oil is there, a lot of people are taking it away, so people start experimenting... how to get the resources under their own feet” (Toboni, 2018).

The Niger Delta Avengers are a part of these communities hit hard by the pollution and take part in oil bunkering and illegal refining. They continue to affect oil production but at the expense of who? They are inflicting damage on the oil industry, attracting the audience of political leaders to resume payments. But the environment is contaminated after illegal refining, military raids, and pipeline spills (Toboni, 2018). When civilians fish within these oil-ruined areas, fishing nets are covered in oil, and “when I eat it, it will give my body a burning, hot fire! You can’t sleep, no sleep” a fisherman says (Toboni, 2018). He then explains that before oil, the community’s water supply was not polluted and how they could catch

plenty of fish and get by, but now with pollution, they have no fish for food or income.

Gianna was able to interview the Avengers, and she asked them why they were doing the activities they were doing and what was their end goal:

We are sick and tired of this shit. I feed you, you get fat, you make money, you live large, and you keep me in a poverty stage? It’s not possible! We have kids coming up. The future, we are not looking at the present, we are looking at the future. If this continues, what do you expect for my son? What do you expect from my child?

We are there to stop the operation. We blow up the pipeline. We are not there to kill humans. Just the pipelines.

Vice President Osinbajo states that the Niger Delta Avengers are “not Niger Delta freedom fighters or working for the interest of the Niger Delta people as they claimed to because if they were, they would not engage in the destruction of the source of economic power of the region” (Abutu, 2017). He elaborates that the Avengers create more problems in the region by polluting the environment and making the communities’ lives more difficult. However, blaming rebels for damaging the economy and environmental issues ironically defeats the purpose and underlying problem- that this is a cause-and-effect problem. Dr. Ian Ralby summarizes the situation perfectly:

As significant as the link between oil theft and terrorism and other international crime may be, it is worth noting that it exists within a complex web of causes and effects. The Niger Delta Avengers... would not have become a terrorist group if it had not been for the economic benefit the Delta State militants had been receiving, the corruption that allowed those economic windfalls, or the environmental degradation that has made corrupt and illicit oil-related activities

their most obvious source of income (Ralby, 2017).

The government's unwillingness to significantly address the problems oil companies have inflicted on communities and Shell's lack of responsibility and violent activities have created rebel fighters, hence adding more oil spills and environmental degradation and the willful negligence contributed by the government (Maiangwa, 2013).

## **US Foreign Policy**

The United States has taken a leading role in condemning human rights abuses worldwide (Adunbi, 2020). However, they have deliberately shied away from condemning the environmental degradation and human rights abuses in the Niger Delta related to the oil industry (Onwuazombe, 2017). Nigeria is Africa's leading oil exporter causing foreign interests, such as the United States, to become hesitant to publicly criticize Nigeria, especially with their strong ties to Nigeria.

The United States is the largest foreign investor in Nigeria, with investments in the petroleum business (U.S Department of State, 2020). In 2017, the two-way trade in goods between the two countries totaled over \$9 billion, with the US exporting wheat, vehicles, plastics, and Nigeria exporting crude oil, cocoa, cashew nuts, and animal feed (U.S Department of State, 2020). Between January to May 2019, the US imported 21.03 million barrels of crude oil, while this year, the U.S. has imported 2.12 million barrels (Oil & Gas 360, 2020). This sharp decline results from the decrease in demand for oil during the coronavirus pandemic and the U.S. production of shale from our facilities, similar to the sweet crude extracted in the Niger Delta (Oil & Gas 360, 2020). Although the U.S. has imported less crude oil in recent years, they are still importing crude oil from Nigeria, where human rights abuses and corruption are still present.

The main lever of influence the U.S. has with Nigeria are the aid towards anti-terrorist efforts surrounding Boko Haram. Boko Haram is an Islamic sectarian movement where they claim an end to corruption and impose Islamic law (Ade, 2019). Their attacks include targeting governmental buildings, police, Christian churches, and schools (Ade, 2019). Between 2011 and 2018, Boko Haram attacks have claimed approximately 17,000 lives (Kastoan, 2020). These attacks consist of bombing, massacring, kidnapping, and burning entire villages (Kastoan, 2020). The Nigerian Army has received \$2.2 million in funding from the US Department of Defense to develop a counterterrorism infantry unit and another \$6.2 million designated for tactical communications within its counterterrorism unit (King, 2011). U.S. aid has also taken steps to promote governmental action on the number of grievances that occur in the north between Boko Haram and the government (King, 2011). Between 2008-2017, Nigeria received over \$96.5 million from U.S. Security Sector Assistance, which is a policy aimed to strengthen the ability of the U.S. to help allies build their security capacities (Dalton, 2018). In 2019, Nigeria spent \$298.87 million of U.S. aid on Humanitarian Assistance (U.S. Foreign Assistance, 2020), with a majority of the aid focused on fighting against Boko Haram activities.

## **Policy Recommendations**

The issue of terrorism occurring in the north has diverted international interest away from the matters in the Delta, leaving people to suffer. I am not alluding to the fact that any crisis is less important than the other, but U.S. aid needs to address problems in the Delta as well as the Boko Haram crisis. The U.S. needs to withdraw their support of the Nigerian government if they do not enforce their gas flaring laws, oil spill cleanups, and stop the continued abuse of communities' human rights. Aid from the U.S. needs to be injected into the economy for development toward the Niger Delta, so

militants aren't dependent on illegal refining, kidnappings, and oil bunkering to address their grievances. The U.S. should provide financial resources for proper clean-up of areas affected by oil spills and gas flaring sites. Aid then needs to be applied to train the local people so they can find gainful employment in the oil industry, and oil companies are obligated to hire a more significant percentage of Niger Delta residents.

Apart from U.S. foreign policy, Nigerian domestic policy needs to revisit and review the 1999 Constitution, UN Charter's, and other human rights documents such as the UDHR and ICCPR. The loophole of allowing certain companies to flare gas needs to be addressed, as it is counterintuitive to the Associated Gas Re-Injection Act. As well as gas flaring, oil spills need to be cleaned up promptly, as stated in Nigeria's National Oil Spill Detection and Response Agency Act. The appropriate penalties need to be implemented when these laws are broken. The enforcement of these documents is crucial to the improvement of the situation occurring in the Niger Delta.

Since petroleum is the driving force of Nigeria's economy, the government needs to go back to the original 45/55 split of oil profits. These numbers halt the government's investment in oil extraction and give local communities a significant stake in the exploitation, distribution, and oil revenues. These numbers were once acceptable and agreed upon by both parties, and this will eliminate the rise of militant groups and address the Delta's economic and environmental issues.

Until renewable energy is more established, the profits from oil need to go back to the communities located in oil-bearing areas. However, attention also needs to be paid to renewable energy and the Niger Delta, especially when fossil fuels are no longer the driving energy of the world and income for the Delta residents. There needs to be a safety net while the shift from fossil fuels to renewable

energy occurs, so the people in the Niger Delta are not left behind to suffer in oil devastated areas with a lack of income.

## Conclusion

The government's policies and the corruption of oil companies have given rise to political unrest that has created an even more intolerable environment for the people. The reality for the Niger Delta communities is their water, food, soil, and livelihoods are ruined by the exploitation of oil, and they live in a violent country where different factions senselessly kill innocent people. Their fundamental human rights have been removed, and they live in fear of sickness, hunger, poverty, and death.

Many Americans also understand the danger of pollution and have witnessed its harm in their own neighborhoods. Although they see its impact on the US, many may not realize what's going on across the globe and how these occurrences are impacting others. Perhaps this understanding can create a bridge of unity to help Nigeria in the long run and help the world address these insecurities. There are some things the U.S. government can do to positively affect the Niger Delta. Firstly, they need to support economic growth and development for the Niger Delta communities' by giving aid for environmental cleanup and providing education to enable them to find gainful employment in the oil industry. Next, the U.S., along with other countries, need to stop turning a blind eye to the corruption that exists in the Nigerian government and the persistent human rights abuses. Finally, they need to withdraw their support from Nigeria until they have shown positive intent to change what is currently occurring. The Nigerian government needs to ensure that the Niger Delta communities receive their fair share of profits and abide by laws and legislation passed that reinforce the peoples' fundamental human rights. Also, a proactive discussion and plan for how the Niger Delta will survive once global energy companies reduce their carbon footprint

by moving towards renewable energy needs to happen.

If all these recommendations are actioned, the Niger Delta people can have the opportunity to live a more peaceful and fruitful life.

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# FEELING THE BURN: AN ANALYSIS OF JOB BURNOUT AND PREVENTATIVE SOLUTIONS

Jeff Liao

*ABSTRACT: Job burnout occurs when an employee works under high stress for long periods of time and feels no sense of accomplishment. Given the cost of replacing employees, human resource managers around the world currently face a challenge in preventing occupational burnout from developing in employees. This study aims to determine the causes of job burnout, the effects of job burnout on the brain, and what companies are doing to address it. Through multiple studies, it was found that there were different reasons employees had for burnout depending on what life stage they were in. Young employees were concerned about lack of personal resources and were the most likely group to suffer burnout. Middle-aged professionals were typically exhausted by trying to maintain work-life balance. Late-career employees frequently cited caregiving concerns and personal health issues as reasons for burnout. Neurological changes included an enlarged amygdala and the thinning of the frontal cortex, both of which result in a weakened ability to control negative emotion and decision-making. To combat burnout, HR managers can tailor their administrative policies and employee assistance programs to match the needs of each life stage. They can foster employee resilience, encourage a positive team climate, and increase job resources in order to prevent employee burnout. South Shore Hospital is an example of fostering employee resilience through a stress management toolkit. Through these solutions and pairing them with burnout assessments such as the Maslach Burnout Inventory, Human Resources managers can reduce turnover rates, increase work engagement, and improve employee health.*

## Introduction

When working in a profession, especially a high stress one, the mental and physical exhaustion can be overwhelming. Thoughts, once positive and empathetic, turn cynical and nihilistic. Depressive moods like this can be a sign of job burnout. While there are many different definitions for work burnout, most of them mention feelings of exhaustion, cynicism, and inadequacy at work—all of which stem from a variety of professional, personal, and economic reasons. More specifically, the World Health Organization has identified that high job demands, low control, and effort-reward imbalance are consistent risk factors that impact physical and mental health (AMA, 2020).

Given that burnout can be a reason why employees start becoming disengaged from their job or a reason why they quit, the

negative effects of burnout are detrimental to a company's productivity. If employees quit or require extra assistance due to burnout, it puts extra work on Human Resources (HR) to either find a replacement or provide said assistance. How can HR managers reduce the possibility of employee burnout? The answer to this question will allow for better retention rates, improved employee health, and increased employee engagement. This paper will examine some of the causes of burnout, the effects it has on the brain, evaluations of past mental health initiatives, and ultimately what strategies HR can implement.

## Literature Review

It is important to understand the psychological and neurological effects of burnout for HR managers to better understand how to address it. Depending on the life stage the employee is in, there are a variety of reasons that can

contribute to occupational burnout. According to a 2018 study conducted by Salmela-Aro and Upadaya, when a young individual initially enters a career, they find themselves low on many resources such as time, income, and work experience. Because of this, these personal resources are often outmatched by their job demands. This can cause a workaholic attitude where young professionals might be forced to overdraw on certain personal resources to close the gap between available resources and job demands. Through their research, Salmela-Aro and Upadaya found that younger employees are at the highest risk of experiencing burnout due to income-related reasons.

For the mid-career stage, the wide variety of responsibilities and obligations the employee must balance can generate burnout. For instance, a middle-aged working adult may need to focus on raising a family as well as maintaining their professional status. This balancing act can create or worsen work-family conflict where an individual feels split on how to give each obligation the proper amount of time (Salmela-Aro & Upadaya, 2018).

Unsurprisingly, employees in the late career stage are more likely to be burnt out by caregiving demands. The people in this stage most likely have parents who are either retired or have started to develop health-related issues. Not only that, but late-career professionals must also focus on their own health due to the increased likelihood of developing health problems (Salmela-Aro & Upadaya, 2018).

Overall, it was found that employee resilience, high ranking, positive team climate, personal resources, and job resources were factors that were positively associated with work engagement. On the other side, personal demands, economic problems, job-related demands, and authoritarian management were factors that were positively associated with work burnout (Salmela-Aro & Upadaya, 2018).

In a 2014 study by Golkar et al., the brain undergoes many changes when exposed to constant stress which subsequently leads to burnout. In short, burnt out participants looked at a series of emotionally neutral and negative pictures. This photo task session was also done with a control group of 70 individuals who were healthy and did not exhibit any signs of burnout. The burnout group had more of a dramatic response and had increased difficulty controlling their negative reaction to a loud, startling noise that randomly played than the control group (Golkar et al., 2014).

The second session consisted of a brain scanning. The amygdala, which is responsible for emotional reactions like fear and aggression, was larger in the burnout group compared to the control. Additionally, the connections between the amygdala and the brain areas associated with emotional distress were markedly weaker in comparison to the control group. These areas are linked with empathy, impulse control, emotion, and decision-making (Brain, n.d.). The physiological effects can explain why employees suffering from burnout exhibit signs of cynicism, irritability, and apathy (Michel, 2016). Other studies, such as Ivanka Savic's 2015 study suggest that in addition to weaker connections in emotion-processing areas of the brain, physical changes can occur—for instance, the thinning of the medial frontal cortex, which is associated with memory and fine motor skills, among others (Brain, n.d.). This causes burnt out individuals to have trouble remembering routine tasks and experience poor hand-eye coordination.

There has been increasing pressure from employees for employers to create policies on mental health. The healthcare industry is an example of a high stress environment that can lead to burnout which can lead to high turnover rates. Recognizing this problem, South Shore Hospital did an experiment where they implemented a stress management toolbox. In this toolbox were guides on how to manage stress based on

practices of cognitive behavior therapy, positive psychology, mindfulness-based stress reduction (MBSR), and the relaxation response. All these tools would be self-administered, essentially teaching nurses how to help themselves in times of high stress. After a certain amount of time, the researchers did a follow-up perceived stress scale (PSS) which was a questionnaire inquiring the nurses about their stress levels. The results of the surveys found that there was a “modest downward trend in perceived stress scores for the intervention group, while the control group’s PSS continued to rise” (Wood, 2012). The decrease in perceived stress in the group that was trained in mental resilience practices clearly demonstrates that fostering employee resilience is an effective method of reducing the possibility of burnout.

## Key Takeaways and Solutions

The first important takeaway is that HR managers can predict when and why an employee is experiencing burnout. Salmela-Aro and Upadyaya’s 2018 study discovered the main stressors for employees at the early, middle, and late life stages. By knowing the common reasons for burnout at each life stage, HR managers can tailor support programs towards employees based on whatever stage they are in or approaching. Based on this study, HR can even preemptively address the main reasons for burnout before the employee even experiences them. Human Resources managers can utilize these takeaways in many ways. For example, since young employees are most likely to be burnt out from a lack of personal resources, HR can offer attractive financial rewards like signing bonuses or highly competitive salaries.

The study also gave insight on general aspects of a company that can either improve work engagement or detract from it. To raise work engagement across the board, HR can do several things. One is to implement initiatives to foster employee resilience. The South Shore Hospital case study is a real-world example of

an employee resilience initiative that managed to reduce the amount of stress that nurses experienced on the job. Another way HR can avoid occupational burnout is to maintain or grow positive team climates or increase the amount of job resources such as autonomy.

Next, the neurological changes that burnout causes in an employee’s brain demonstrate how harmful burnout can be to their health. The neurological changes to the brain may explain why employees experiencing burnout are typically exhausted, cynical, and unempathetic. Employees who show signs of these traits should not be dismissed by way of the fundamental attribution error. Dismissing burnout as the employees’ fault can aggravate the condition and lead to worse consequences, like higher turnover rates and toxic work cultures. Thus, it is vital that HR be able to identify, understand, and empathize with employees who are displaying symptoms of occupational burnout. Hosting burnout awareness workshops should help employees recognize signs of burnout in themselves.

HR should utilize assessments to be sure that burnout is at play, such as the Maslach Burnout Inventory which tests for levels of the three main components of burnout: emotional exhaustion, depersonalization, and reduced personal accomplishment (Maslach, 2005). Adjustments to the cutoff scores may be needed as there is no fine line between being officially burnt out and not. A study by Berjot et al. suggests that using cluster analysis instead of cutoff scores to assess risk groups would be a better way to determine what specific employees are at risk of burning out (2017).

In conclusion, burnout is an issue that should be taken seriously in the workplace. The early, middle, and late life stages are associated with concerns of personal resources, work-family balance, and health (respectively). After identifying burnout through assessments and awareness workshops, HR managers can create

effective employee assistance programs. In the case of South Shore hospital, implementing a stress management toolkit proved useful in fostering resilience in nurses. Generally speaking, to improve work engagement and avoid burnout, HR should foster employee resilience, protect their neurological wellbeing, and increase job resources.

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# A HOT DUTTON ISSUE

Marina Burandt

*ABSTRACT: Danielle Dutton is an American writer and publisher that utilizes style in fresh and exciting ways to juxtapose old-fashioned concepts and feminist modernity. I will examine multiple published works of writing by the author in order to determine which stylistic elements are being used, and how they affect the writing as a whole.*

## Introduction

Danielle Dutton is an American writer, publisher, and current professor of Creative Writing at Washington University in St. Louis, Missouri. Dutton is also the co-founder of The Dorothy Project, a feminist press that focuses on smaller works done primarily by women. She has received wide recognition and appreciation of her first novel released in 2009, which is set in the 17th century and takes the real life of Margaret Cavendish and pushes it into the realm of fiction and modernity. Her interests, evidenced in both her own writing and the work she selects for publishing via the Dorothy Project, are wide and varied, which makes each of her works fresh and vibrant for even the most jaded reader. Much can be divined from analyzing an authors' writing compared to other writers, but it is less common to contrast the writer's work with themselves. By comparing work written by the same author at different times, the unique voice and style can be more easily revealed, including the juxtaposition of literary elements like the making of lists and feminist inspirations that connect Dutton's works.

### Margaret the First & Attempts at a Life

Published nine years apart, *Attempts at a Life* and *Margaret the First* display vastly different approaches to writing, as well as document the great strides Danielle Dutton has taken in her approach to the overarching genre of fiction. There are evident thematic similarities in subject matter; Dutton is clearly interested in women writers (as well as Louis-Ferdinand

Céline and William Carlos Williams) of the past and the stories they had within and without their own writing. Clearly the circumstances that led these women, in different ways peculiar, heroic, and wild, to become acclaimed writers is critical to Dutton's message through her work. By comparing Dutton's first book with her most recent, the poetic strategies that she employs become significant, and show how Dutton was able to expand upon ideas born in *Attempts at a Life* into a focused and rich narrative evidenced in *Margaret the First* with great success. The book communicates its own poetic sensibilities from the initial impression given through a quote by Gertrude Stein as a preface: "And it is necessary if you are to be really and truly alive it is necessary to be at once talking and listening..." (AaaL 1). This quote sets up the book quite well in terms of how each section contains a different, and often multiple different voices, both taking material from past works to be rewrought and creating new material with inspiration taken from the writers in question.

In Steinian fashion, Dutton manipulates language through "expert, miniscule slips" (Peter Connors, Rain Taxi) and while the words maintain more of their literal clarity than Stein's poetry, the effect is similarly successful. In the section "Selections from *Madame Bovary*," this manipulative practice is evident through very brief segmented stories in the form of chapters: "She *finis* came to the puffed-thumb Emma person. Provincial and jolly, wasn't square in the rattle. The rockets candle her, then collapse" (AaaL 44). The words teeter on the

edge of complete understanding, reveling in the confusion and similarity of the words that jut out and bump together on the page. Even the section inspired by *Jane Eyre*, titled as such, weaves in and out of conventional language to create an entirely new but perhaps not unwelcome voice for a well-known literary figure. The slips become more natural, even within a few lines of the chapter, and more difficult to parse out which linguistic decisions are made. While *Attempts at a Life* endeavors to create slices of each of the character's lives in a powerful but brief manner, *Margaret the First's* length alone allows Dutton to elaborate on her personal writing interests to a greater extent.

One major and evident difference is of course, the narrative structure present in *Margaret the First*. *Attempts at a Life* is broken into a multiplicity of small-portioned text, some only a couple lines long while others are many pages. *Margaret the First* follows a chronological order of Margaret Cavendish's (fictionalized) life, with sections dividing major events, changes, and stages of life. What is similar in Dutton's arrangement of text are the frequent page breaks, sectioned off tidily even when the diversion is abrupt. This organization, or perhaps the illusion of organization, allows the text in each piece to be self-contained while also operating within the greater structure of each book. On *Margaret the First*, "It's bold, tender, funny and strange; a short book, but not in any way slight, more like a fever dream which brings a real, eccentric, talented woman unnervingly to life even as it showcases its author's rare and lavish gift for the conjuring up of the unreal" (Belinda McKeon, author of *Tender*, in *The Irish Independent*). The work is indeed both feverish and dreamlike, and exemplifies organized chaos by a deft hand.

*Margaret the First* follows a narrative structure, albeit one that switches perspective and verb tense throughout the novel. The reader is thus moved closer and further from the main character's story, able to partially embody Margaret when the tense remains in the first

person and then to examine her situation from a removed position in the third person. This same stylistic choice is echoed in *Attempts at a Life*, though the stories primarily stay in the first person, while others take a third person approach. "Mary Carmichael," which begins on page 67 and ends on 71, remains in the third person narrative voice throughout the piece. This allows the reader to take a step away from the characters and is of course an intentional poetics decision. "Attempts" as a choice of word in the title implicates that perhaps these lives as they were lived were not entirely successful, or at least not in the traditional sense. They contain tainted broken chronologies, multiple voices, and unreliable narration throughout misinformation and ornamented numerical figures on the brink of fiction.

## Feminist Focus

The fact that Dutton intentionally writes with a focus on women is another deliberate use of poetics; she seems to hint at the abundance of information and attention turned toward male authors throughout history. While their feminine counterparts overlooked and disparaged in equal measure. In eras where the education of women was inadmissible or punished, it is a marvel that women learned to write (often from a higher social class with the means to do so) and made lasting impressions on the literary canon despite consistent misogynistic dissent. Margaret Cavendish, the star of *Margaret the First*, is one outstanding example of this, reveling in her unique brand of creative nonsense despite criticism. While there are two male writers represented within the smattering of found material, there is clearly a focus on the women writers and the feminine experience overall. Sex and the body are recurring themes both in *Attempts at a Life* and *Margaret the First*, centered from a woman's perspective. This furthers the idea that Dutton seamlessly blends each voice into the next, as the feminine perspective often carries over each piece regardless of source material.

### The Style of Lists

*Attempts at a Life* is Dutton's first novel and was published in 2007 by Tarpaulin Sky Press. It was well-received, and furthered Dutton's career greatly. Perhaps summing it up the most succinctly is the following review excerpt: "Indescribably beautiful, also indescribable. In fact, I'm not quite sure what this book's about, really" (Daniel Handler, *Entertainment Weekly*). This statement of confusion is a bit unexpected, and perhaps reveals more about the reviewer's unwillingness to delve beyond the surface of the book. Because it attempts to accomplish much within its scant 73 pages, one might argue that the book is indeed too nebulous to be making any critical point to its fullest possibility. Due to its small-portioned nature, it contains elements in near equal measures of poetry, biography and fiction. There are sections which take material or inspiration from *Jane Eyre*, Louis-Ferdinand Céline, Katherine Mansfield, Sappho, *Revolution of the Word*, Alice James, Diane Williams, Gertrude Stein, Ann Quin, Ann Radcliffe, Virginia Woolf, and William Carlos Williams. Thus, it can be surmised that intertextuality is hugely important to the sense of the piece overall. The voice of the book, while obviously being filtered through Dutton's own writerly sensibilities and choices, blends surprisingly well together, a Frankenstein assemblage of a multitude of found sources. The original writers of the sources are scattered across the globe and throughout time, from Sappho, estimated to have been born in 630 BC (*Sappho in the Making*), to Diane Williams still alive today. Both the similarities and the differences between the language are woven into the final product, which echoes Dutton's own writing voice, especially in passages with beautiful, list-like descriptions.

The lists have become indicative of Dutton's writing style, only increasing in frequency since *Attempts at a Life*, which does have the presence of some lists, some much more peculiar than others: "But life changes on a dial, in a garden, a

clinking of beetle wings, a shrimp bush and dry pink petals of chinese lanterns dangling" (AaaL 9). Sometimes Dutton uses her convention of beautiful list-making to humorous effect: "a lily, a pomegranate, a noodle" (AaaL 33). In comparison, *Margaret the First* is absolutely riddled with lists, adding to the sense of Margaret's own dreamy perception of the world: "The sea, the air, the double white violet, the wallflower, stock-gilliflower, cowslip, flower-de-lice, cherry trees in pink" (MtF 24); "Beds like ships from China, or beaded purses, in black and white, or pearly" (MtF 38); "Flemish tapestries, drawing tables, lenses, the telescopes from Paris, books, of course, and perfumes, platters, ewers, ruffs, tinctures, copperplates, saddles, wax" (MtF 86). What seems of massive importance to both Dutton and the character Margaret is food, which are treated in very much the same fashion as the beautiful features of nature or decor: "Roasted carp, claret, a shoulder of mutton with thyme, and a fine sugar cake with sprigs of candied rosemary like diamonds" (MtF 39), "On the buffet sat wine, cheeses hard and soft, bread, poached apples, berries or asparagus, fish with horseradish, sliced salted ham" (MtF 41), "an olio, a spicy Spanish stew (a pinch of this, dash of that, onions, pumpkin, cabbage, beef)" (MtF 70). Dutton's use of listing is a stylistic one that yields a great deal of information within a short space, giving more or less equal importance to each item listed. It also allows the reader to be caught up in the pacing of the text, carried away in the often-fanciful lists. The sense of abundance of objects, of scenery, of food or decoration, all adds to the decadence of Margaret the First's rich life, a masterfully subtle way to show not just presence of the objects, but their plenitude.

### Margaret Cavendish as Inspiration

Readers of Renaissance drama may be familiar with the fascinatingly joyful and strange work of Margaret Cavendish, most notable of which is her closet drama *The Convent of Pleasure*. It is a unique take on relationships and the

comedy that can arise from these relationships in a woman's perspective. *Margaret the First* explores many more avenues of her life, albeit while fictionalizing and creating some of the historical detail. Dutton effectively makes Cavendish's life feel as fresh and faceted as any modern woman. As Dutton tells it, Cavendish could see entire universes in water bubbles and inside ladies' earrings. Margaret was able to pursue her fantastical thoughts in writing far into her adult life. True, she was discredited constantly, not only for her gender, but also for her eccentricity. However, it's nonsensical in my view to see only essays with hard-hitting philosophies or factual evidence as valuable literature. Fantasy, nonsense, and flights of fancy all deserve their place on the shelf alongside the research papers. Not every work of fiction needs to undergo rigorous searches for meaning on some higher plane of learning. Creative nonsense can be just as important at face value. It demonstrates in its own way the potentiality of response to a certain time in history outside of scientific discovery or popular philosophy. She was nothing if not authentic to herself. Margaret saw herself in an elevated way, picturing herself as a queen or a princess, and an otherworldly one at that. She reveled in her own femininity despite her profession's condemnation of it. She never had children nor seemed to place her self-worth on this fact; Margaret was a proto feminist who saw value in her existence and thoughts in the face of a patriarchal oppression and frankly, revilement. Perhaps this demarcates Dutton's increased confidence in her choice of subject matter, having addressed celebrated writers, such as Charlotte Bronte and William Carlos Williams, and culminating in *Margaret*, an extended case study of a routinely dismissed and loathed woman whose work was often not even considered to be real writing at all. Even her spelling, which was often incorrect though understandable through sound and context, is addressed in *Margaret the First*: "'Passionitt,' they sniggered—it seems my spelling did astonish—'sattisfackson,' 'descoursee' for

'discourse,' even 'Quine' for 'Queen'" (MtF 68). This mode of writing is put to great use by Dutton, at once addressing found excerpts of Margaret's actual writing as it happened, intertextually. If the reader is to ponder on it for any length of time, be gently reminded that despite expertly embodying Margaret's voice, it is Dutton the author writing about Margaret's writing. One huge clue into Dutton's poetics lies within this concept, and is evidenced again in *Attempts at a Life*, the section titled "How I Met Mikhail." In it, the reader audience can see the birth of the reader illustrated beautifully: "I'll open it on the train ride out of the city. It is a book. In it, I encounter myself on every page, but the me I meet is never the me I remember. It's me but me a misanthropic barber, me a German, a werewolf; or it's me but me advancing, me in slippers, me alone under a great grey sky" (AaaL 54). This is perhaps the greatest stride Dutton makes throughout her work; she is able to see herself within each of her subjects and thus maintains not only unique voices for each of her characters, but not to lose her sense of self as she does so.

## Conclusion

Dutton honed her craft to the point at which a single concept explored in multiple ways could be expanded to an entire novel, maintaining themes of found material, historical fiction, and manipulations of language with great effect. With such a relatively small body of work, beginning with *Attempts at a Life*, and including two other novels between its publishing and *Margaret the First* (stream-of-consciousness *SPRAWL* and comic opera *Here Comes Kitty*), it is relatively easy work to consume Danielle Dutton's entire breadth of work in quick succession. Her style is evident whether she chooses selections of found text as in *Attempts at a Life*, or by employing her own unique and fresh take on historical fiction in *Margaret the First*. Whether the evidence is in subject matter alone, in revitalizing writers of the past into refreshingly contemporary voices and personas, or in decadent list-making to provide

an abundance of objects in which the reader can be ensconced deeper into the particularity of setting Dutton so expertly weaves. No matter how naturally bleak or beautiful the lives and places were in reality, Dutton is able to write about them with an eye toward their most essential qualities.

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# MURDERERS AND MAD SCIENTISTS: DECONSTRUCTING THE TROPES OF GENRE FICTION WITH FEMINIST NARRATOLOGY

Joe Lollo

*ABSTRACT: This paper aims to combine genre theory and feminist literary criticism to examine how female writers of genre fiction utilize the concepts of narratology and characterization to critique the patriarchal systems that created the genre and character archetypes they fall under. Through the specific deconstruction of tropes in Gillian Flynn's neo-noir *Gone Girl* and Larissa Lai's cyberpunk novel *The Tiger Flu*, the authors show how narratological concepts, combined with the subversion of tropes and character archetypes, can be combined with feminist knowledge to critique gendering in noir and science fiction and shape new literary canons for female writers.*

## Introduction

Narratology is “a branch of literary analysis and writing dealing with the structures and functions of narratives,” as Susan S. Lanser explains in her article “Towards a Feminist Narratology.” Feminist narratology is a writing practice dedicated to exploring implications of sex, gender, and sexuality to understand the form and functioning of narrative, thus exploring the full range of elements that constitute narrative texts. This form of thinking is compatible with a variety of genres, where narratological concerns and feminist criticism are used in conjunction to address the problem of gender-based tropes. Two contemporary works of genre fiction to note are *Gone Girl* by Gillian Flynn and *The Tiger Flu* by Larissa Lai; both of which use several concepts of feminist narratology in their works to explore their genres’ gendered characterizations of the femme fatale and the mad scientist, critiquing the patriarchal systems those genres and characters are bound to.

Lanser’s article provides insight into the origins of the practice of feminist narratology, which blends feminist critiques with semiotic studies of literature. Narratology, as Lanser states, is “the study of narrative structure and the way it affects human perception,” often looking at “the distinctions between the

‘story’ behind a text and its resulting discourse in and outside the text.” She believes that “feminist criticism, and particularly the study of narratives by women, might benefit from the methods and insights of narratology,” and that narratology, as a result, “might be altered by the understandings of feminist criticism and the experience of women’s texts” (Lanser, 342). Lanser offers a deconstructive approach to narratological criticism, arguing that certain narrative strategies can provide women with opportunities for representation and ideological meaning. Authors like Flynn and Lai use these narrative strategies in their respective genres and combine them with common literary and popular tropes to make a statement about their genres, which have historically given female characters and writers little importance.

## Noir and *Gone Girl*

The noir genre is characterized by its thin line between “good” and “evil” and its attitudes of fatalism among characters. The defining female character of this genre is the femme fatale, a figure described by Jack Boozer’s genre study “The Lethal Femme Fatale in the Noir Tradition” as “closely tied to undercurrents of sexual, social, and ideological unrest.” Femme fatale characters are typically ambitious and sexually liberated, striving for more independence, and

readers are meant to view them as “visionary villains” whose ambition makes them act this way (Boozer, 20). They often contribute to the “profound social alienation” of the genre’s male narrators, as Kenneth Lota states in “Cool Girls and Bad Girls: Reinventing the Femme Fatale in Contemporary American Fiction.” These women, Lota argues, are treated as “objects” and are “rarely endowed with the same narrative control” as their male adversaries (Lota, 151-152). In the context of noir, then, feminist narratology works by giving a perspective on the social alienation of women. Gillian Flynn’s *Gone Girl* uses these narratological structures to provide a fresh take on the femme fatale through the character of Amy Elliott Dunne, one of the two primary narrators in the novel, and her deconstruction of expectations in both the noir genre and the world.

“Fantasies of women are sociohistorically based, and thus affected by, the position of women in any given historical movement,” and as a result of their creation in the post-World War II era, “typical” femme fatales usually do not control the way the story is told, but rather only indirectly influence it on the narrator (Lota, 152). If Amy is read as a femme fatale, then she is characterized by how she manipulates gendered expectations in a way that subverts yet reflects her gender. She controls the direction of the story in a constant push and pull against her husband Nick. Amy’s hatred of women, for example, is a form of internalized misogyny, and comparing it to Nick’s gives way to a deeper understanding of how she functions as a femme fatale. Nick’s misogyny was ingrained into his mind thanks to the oppressive patriarchal system in his family, leading him to subconsciously think like his father at times, but Amy’s hatred is a more personal vendetta – she is driven to be perfect and more important than other women because of family pressures. Her childhood was cannibalized through the *Amazing Amy* books, children’s books written by her parents portraying a fictional Amy as the “perfect child” they wanted. Rather than seeing

it as an upbringing, Amy perceived her life as a disappointment to her parents’ constructed narrative. This transformed Amy into a perfectionist determined to keep control of her life, and by extension, the lives of those close to her. Because the fictional Amy touched the hearts of many, the real Amy saw her parents’ creation as a way of undermining her femininity and agency. This desire for power over the discourse in her life is what drives Amy to be the femme fatale in this noir work, allowing Flynn to give a narratological perspective to the femme fatale, an unfortunately gendered and one-sided archetype. Women are vilified in many noir narratives for simply being women, and while she is still considered a villain in lieu of her status as a femme fatale, Amy’s gender is not the aspect that vilifies her ambition and her desire for control.

### Narrative Control

Amy’s diary serves as a plot device to fulfill her desire for narrative control, through feminist critique of noir and the narratological concept of heteroglossia, the “usage of different languages, narratives, or voices as a subconscious subterfuge” of readers’ expectations (Lanser, 350). The motif or theme of writing is common in noir, as characters who investigate and control the narrative in the genre are traditionally men working as detectives or journalists. This motif is present in *Gone Girl* because Amy and Nick were both writers by trade – as producers of discourse, they manage. They both want to be seen as the righteous person in their narrative and conflict, but Amy’s manipulation of the narrative only makes her ambition stronger.

Amy created her diary to seem innocent and “like a victim,” both when she faked Nick’s murder and after she murders another man. Readers both in and outside of Flynn’s crafted world are given a glimpse of the usage of false narrative to gain control – Amy desires to be perfect, to be “Amazing Amy, the girl who never did any wrong,” but her parents’ social scripts turned her into this (Flynn,

229). She became desperate for control over the narrative of her life and how others view it and used “Diary Amy” as an outlet to have the final word. Her status as “Amazing Amy,” what several people know her as, makes her want to hold herself apart from other women, and she takes any opportunity she can to put down and generalize the other women she is around. She created “Diary Amy” as an outlet to criticize those women, too – her constructed “Cool Girl” image, a “hot, brilliant, and funny” woman that “men think exists” and “women are willing to pretend to be,” is harshly criticized in her narration, as are women who “fall into any roles men make for them” (Flynn, 218). Amy used the fact that everyone loves the “Cool Girl” due to her submissive and friendly nature to give herself an advantage in constructing a narrative that people would believe, a narrative she could gain control over (Flynn, 220). When the reader thinks they find an answer to Amy’s supposed murder, the revelation of her diary being a falsified narrative in the second part of the book changes and raises the stakes of the novel. Changing the novel’s central question from “what happened to Amy?” to “what will Amy do next?” using the diary, Flynn subverts the expectations of readers who thought they had Amy figured out as the victim she was not.

## Heteroglossia

A key aspect of feminist narratology ripe in *Gone Girl* is the presence of two or more voices or expressed viewpoints in a text that lean towards the same argument, the aforementioned heteroglossia. This happens in the novel through Amy’s critique of “acceptable” behaviors for women in society. As a private narrative, “Diary Amy” is an explicit subtext – her voice in the diary expresses things that Amy cannot express in her real life due to her parents’ expectations and Nick’s control over her life. Upon becoming “Dead Amy” to further her scheme, Amy keeps her true self a private narrative only seen by her and Nick, pretending to be someone she is not to the public to finally establish dominance in

her narrative and keep Nick under her control. While Amy is a cruel psychopath, Flynn makes her a somewhat sympathetic or charismatic version of the femme fatale in a slightly twisted way thanks to her usage of heteroglossia. Amy uses gender roles and stereotypical views on women to challenge the oppressive systems that create them, exemplified through her desire for narrative control, something women, especially femme fatales, rarely receive in noir stories. Flynn uses the diary as a private discourse to “call out” and play with readers’ expectations for what happens to the femme fatale.

Thanks to its recurring theme of writing and narrative, Gillian Flynn goes one step beyond simply critiquing the gendering of the femme fatale, creating one who has at least partial control of the narrative instead of simply desiring control. Amy, like her husband, was a writer by trade. Because of the increasing rifts in their marriage because of her deception, Nick and Amy are both obsessed with taking back the reins of their own stories, leading to a constant struggle for control over the narrative of their lives and their marriage. As Kenneth Lota argues, Amy is then more of a “meta-noir” character, one who “sees through both the tropes of noir and the cultural mindsets of the people around her and uses her awareness of those very categorizing tendencies as a basis for her plans.” She manipulates people using her knowledge of gender roles that they would primarily follow as a basis for her schemes, but her knowledge and invocation of noir tropes make her a threat to Nick’s desire for narrative control and his desire to be seen as a hero (Lota, 167).

Through its usage of feminist narratology, especially heteroglossia, the gender roles in noir – and the oppressive systems that created the genre – are critiqued in *Gone Girl*. In creating a more complex version of the femme fatale, one with a desire to control the narrative on a figurative and literal level, Gillian Flynn demonstrates how Amy Dunne can be written as a dangerous yet multifaceted character despite

the typical femme fatale depiction in male-dominated noir narratives.

### Tiger Flu

Similar to noir, women – and feminist thinking – have never been able to find their footing within the genre of science fiction. In his book *Metamorphoses of Science Fiction*, literary critic Darko Suvin provides a framework for typical aspects of the genre, saying that it “has been wedded to a hope of finding in the unknown an ideal environment, tribe, state, intelligence, or other act of supreme good” within its narrative, often placed in a new world (Suvin, 5). Suvin describes science fiction as “the literature of cognitive estrangement,” a genre both reflective of reality and involving norms different than the reader’s own. This mechanism of estrangement is called the novum, and signals to readers that they are no longer in a realistic world. Building from Suvin’s definitions and analysis in her article “Feminist Theory and Science Fiction,” Veronica Hollinger reads science fiction as “a potent tool for projects of feminist imagination,” one that can do the work of imagining feminist worldviews in societies free of oppressive ideologies (Hollinger, 128). The world in Larissa Lai’s science fiction novel *The Tiger Flu* supports both Suvin and Hollinger’s primary arguments with its feminist narratology. In Lai’s universe, a global epidemic left most men in the world dead or suffering, leading to different networks of women being in power. Through this narrative, Lai subverts the gendering of tropes in science fiction by featuring crumbling societies, typical to the genre, but with women in charge.

A characteristic of Lai’s novel is its imagination of feminist futures, apparent in its narrative. The novel features two narrators – Kora Ko, a poor fifteen-year-old girl, and Kirilow “Kiri” Groundsel, a doctor in the Grist Village, a community of genetically-modified queer women. With its two distinct narrative perspectives, Lai uses principles of feminist

narratology to present readers with a future in which the patriarchy is no more, the Earth is destroyed and humanity is on the brink of extinction. In *The Tiger Flu*, the dedication to improving the lives of others is prevalent in the narrative through subversions of mad scientists.

### Science, Gender, and Objectivity

In the article “Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective,” Donna Haraway argues that objectivity, the “form in science,” is not actually objective but “artefactual social rhetoric of crafting the world into effective objects.” She believes that science has not been truly objective, and rather built on an oppressive system that renders non-male bodies as “others.” (Haraway, 81-83). Haraway argues instead, that true scientific objectivity should come through embodied knowledge, and that how we embody the world through our various social and cultural norms produces meaning. While objective knowledge is often presented with the novum, a “new” science in science fiction texts, Lai inverts readers’ expectations and creates a novum based on the “other” kind through her narrative style. The two main characters in *The Tiger Flu* have distinct narrative styles, proving there is no language or code that translates all meaning perfectly, translating two forms of knowledge across a novum and a human community.

Being a member of the Grist Sisters, Kirilow “Kiri” Groundsel is a part of the narrative’s largest novum, as her network of asexually reproducing queer women is an expression of sisterhood based on shared strengths and resources. Her narrative style is in first-person, subjective and looking at inner thoughts and feelings. She focuses on the body and embodied practices traditional among her community, representing embodied forms of knowledge traditional to feminist and indigenous communities. The perspective of Kora Ko, on the other hand, is in third person and conforms with the reader’s expectations

for realism. As she lives in a controlled society, she is the objective human common to science fiction narratives, interacting with different novums and representing “scientific” knowledge. In her usage of two distinct narrative styles representing two different breadths of knowledge, Lai creates a unique narratological structure, again using heteroglossia to compare and present two different societies – one based in scientific knowledge and the other based in embodied practices. When Kora and Kiri meet, they learn from each other, representing how these two distinct approaches to reasoning can benefit from one another. Kora learns she is a Grist sister from Kiri, while Kiri learns about her true past through Kora’s scales. Their two societies – one on the brink of destruction and the other just beginning to thrive – come together to blur the boundaries between embodied and objective knowledge.

These resistive writing strategies are made stronger through the characterization of different characters as “mad scientists.” The mad scientist is an “individualized genius,” as Suvin points out, based on a humanist critique of post-Enlightenment thought, specifically the turn to science and rationality that increased the importance of scientists in society (Suvin, 7). Science became a tool of domination, and humanists created the mad scientist to represent the over-valuation of scientific thought. They are almost always white men who represent an establishment, because it is the privileged who are seen as “eccentric” instead of dangerous. *The Tiger Flu* features a critique of this trope’s gendering through the novel’s antagonist Isabelle Chow, a woman whose scientific knowledge drives the plot, suggesting a feminist outlook on the dominant discourse in science fiction. The mad scientist as a character is used to project social anxieties about the relationship between science and human nature, and in Lai’s narrative, Isabelle represents an additional anxiety around the culture surrounding science fiction, as well as in the broader world, when the power of science is put in a woman’s hands.

Isabelle’s scientific creations forget embodied experiences, and only rely on scientific knowledge to create fabricated embodiment, typical to the character of the mad scientists. An example is the scales manufactured by Isabelle, used throughout the Saltwater City where Kora’s narrative takes place. Scales, a novum in the story, are used to pass down knowledge in the form of histories and narratives. Not openly available to the public, scales are inserted into the human brain through a false embodiment – by inventing and controlling the scales, Isabelle creates a disparity between people in the City’s Quarantine Rings based on their access to knowledge – she controls knowledge, and in that way, she can control society. Raffaella Baccolini’s article “The Persistence of Hope in Dystopian Science Fiction” mentions that “female characters in science fiction stories often do not contribute to the buildup of negative myths surrounding science,” claiming that women are often the “intermediary between humans and science” in these stories (Baccolini, 51). Mad scientists in other works are almost exclusively male, and by creating one who is a woman of color, in a position of power with control over one of the main novums in the story, Lai demonstrates the flexibility of stock characters in science fiction, subverting their gendered origins.

From a narratological perspective, Isabelle’s scales function as private discourse. The only people who can access them are those with enough money or social status, while the Grist Sisters’ mad science – analogous to indigenous depictions of “science” – consists of the retaining and passing down of information through public discourse and embodied practice. This conflict is what ultimately leads to a conflict between the novel’s central establishments. Learning one’s history through uncommon practices, the way the Grist sisters do, however, is necessary for liberation from oppressive systems – and this disrupts Isabelle, the mad scientist, and her production of the novum. Baccolini states that the “recovery of history and literacy,

together with the recovery of individual and collective memory, becomes an instrumental tool of resistance for their protagonists,” which is exactly how Kora is freed from the mad scientist’s oppressive thought and regime by Kiri. This uncommon way of knowledge, made by the two scientific and non-scientific protagonists joining together, functions outside of empiricist thought and ultimately leads to the destruction of the mad scientist, critiquing the world’s turn towards science, rationality and empiricism by using its novum of the scale as the loss of a traditional way to achieve and transmit knowledge (Baccolini, 520-521). In various stories, the mad scientist is only destroyed by greater scientific knowledge, but a combination of science and embodied practice as the source of Isabelle’s downfall proves that science cannot and should not be the only thing responsible for restoring the values of society. Lai giving importance to non-scientific practices and values through her protagonists is an invitation for readers to understand the oppressive nature of empiricist thought and the dangers of women scientists, an important invitation often unexplored in the genre.

Another common aspect of the mad scientist, especially in science fiction narratives, is their “playing god” – an ability to control who lives and who dies, often through their scientific creations. Isabelle Chow partakes in this action throughout the novel, and Lai uses her status as a woman scientist to critique the fact that mad scientists and technocrats alike use their creations to feel powerful, through her control over the novel’s central novum – the Upload. The Upload is the transfer of consciousness, splitting mind and body, discursive and material properties, with the false claim of immortality. Isabelle has invented a technology to “cure the mind of the body” through the satellites Chang and Eng. This represents giving into objective knowledge, as the satellites are where Isabelle wants people to Upload their consciousness and be slaves to her empire and empiricist thought forever. As a public figure, Isabelle’s

discourse manages to be influential on the material conditions of others, but her private life and private discourse show that she is only trying to get revenge and create a perfect site for the Upload – a future that is feminist in name but not in practice. While she seems to be promoting an ideal society due to her gender and public narrative, this society is void of any real harmony due to its separation of mind and body, and it is driven by her private ambitions and perfectionism. Much like Flynn does with the femme fatale, Lai uses narratological elements of public and private discourse to give the mad scientist a more human edge, driven by her relatable, competitive nature from her private life to create a complicated female character that subverts the trope’s gendering.

Both protagonists and readers are reminded of an important notion as they find out more about the enigmatic Isabelle – science is important, but her mad science must be let go because it forgets embodiment. The mad scientist is no longer considered an idol, but a dangerous threat that comes with relying on science and forgetting yourself, similar to the world’s turn towards science and rationality in the 2010s, when the novel was written. As Kiri says, when Isabelle is using false memories to trick her into Uploading, “Grist sisters believe that body and mind exist together in harmonious balance. When one dies the person no longer exists.” She relies on falsified networks based on real networks people had, such as Kiri’s friends and Kora’s mother, to pacify people into participating (Lai, 239). The novel asks readers to be suspicious of this mad scientist because of her desire to separate the network between mind and body. Despite being praised by the public for her techno-capitalist network, Isabelle is in fact allowing worlds to give in to objective knowledge. Kiri and Kora’s network and narrative go beyond the objective knowledge praised throughout the history of science fiction, creating one of true sisterhood – connected through both situated and embodied thought – to prevail over the mad scientist. Aware of the

dangers of science and the realities that grind down embodied practices in contemporary society, Lai's creation of more "heroic" mad scientists in the end show a healthy stability between the two, a combination resonant to readers who have read too many stories about the dangers and problems of science in the genre. While Isabelle manages to be convincing due to her position of power in this feminist world, it is Kora and Kiri's rejection of Isabelle's promises that allow feminism and feminist narratology to prevail over techno-capitalism and false promises from influential figures.

While Isabelle's science is based on a novum found in technology, typical to the science fiction genre, *The Tiger Flu* uses a feminist perspective to be critical of an integral notion that the narrative of a mad scientist provides. As Lai characterizes mad science as unsafe and promotes a combination of science and embodied practice, she claims that science alone cannot save or improve human lives, and that it is not the solution for a sustainable future. She claims instead that a combination of embodied and objective knowledge is the way to imagine equitable and sustainable futures. As someone bound to science and scientific knowledge, Isabelle is a mirror of several mad scientists – real and fictional – of the past, and Lai's usage of narratology destroys the oppressive system she creates, but not without leaving hope in the story. The novel's ending is ambiguous, a technique described by Baccolini as something that "[allows] readers and protagonists to see hope by resisting closure" (Baccolini, 520). The humanism and naturalism of the Grist sisters, promoted through their network of sisterhood, is improved by HoST technology to foster a more equitable future. The Starfish Tree is an open system, offering hope, opportunities for embodied and objective knowledge, and a sustainable society. In this open ending to the narrative, embodied practice is shown to be as important as science in creating feminist futures, a sign on Lai's end that both forms of knowledge should be equally valued in the genre and the

world. Unlike the thwarted Isabelle, who relies only on science to advance her ideal world and leave behind those who do not follow, the Grist sisters and their mad "science" combine scientific knowledge with their traditional sisterhood, leading to a potential improvement almost never featured in stories centered around mad scientists.

## Conclusion

Feminist narratology in both *Gone Girl* and *The Tiger Flu* is a tool to subvert several tropes common to the genres they are a part of. This subversion goes beyond that, and is used as a resistive writing strategy against popular genres traditionally created and enjoyed by men. Amy Elliott Dunne and Isabelle Chow are very similar characters, as they use their knowledge of narratives to fuel their similar desire to control the narratives and lives of others by limiting perceptions of the truth. Despite this, Amy is additionally much like Kiri Groundsel despite their fighting on opposite sides in their respective narratives, as their uncommon narrative styles complement the more traditional one of each novel's opposite narrator. In many senses, these narratives are similar for what they do – they are both cases of female writers creating strong female characters that distort readers' perceptions of the limits that these genres provide if viewed under any other lens. As none these characters do not conform to a binary opposition of "good" and "evil" common to literature, it makes for an interesting contrast to previous works in their genres, as both deconstruct the tropes that their genres were thought to be bound to.

The strategic writing practices used by Gillian Flynn and Larissa Lai in their novels show a great change in what is deemed "acceptable" in each genre's canon. While noir stories are traditionally told under the lens of a disgruntled man summarizing events, much like Nick Dunne in *Gone Girl*, Flynn pays special attention to Amy's inner feelings and perceptions of the

world around her. This is often achieved through material objects and their additional narratives, which provide readers with the perspective of a villain that would have been reduced to a mere side character in another noir author's work. This makes readers more sympathetic to Amy's motivation than they would be in a male author's work by playing with the gendering of her characterization. Science fiction texts almost never portray female characters with as much importance as they do in *The Tiger Flu*, and Lai's awareness of that fact, combined with the integration of uncommon tropes in the genre like creating a new norm of queerness and deconstructing of the distinction between objectivity and subjectivity, allows readers to feel agency for her mad scientist characters, immersing themselves in a world that ultimately promotes equality through the presence of hope. Flynn and Lai both use feminist narratology as a form of resistance – they provide more agency to their multifaceted female characters as a way of reimagining the standards of their respective genres, a reimagining that becomes a deconstruction thanks to each writer's knowledge of narratological concepts. The histories of noir and science fiction are parallel to one another due to their status as being written by and for men traditionally, alongside the lack of women's roles in them outside of stereotyped supporting characters. Contemporary novels like *Gone Girl* and *The Tiger Flu* subvert the traditional gender representations in the genre by, most importantly, giving their characters independence. They are permitted freedom from the tropes in their genres, representing a break away from the traditional way of writing women, complicating and changing readers' expectations. The novels' stakes are different due to these multi-faceted female characters despite the same formulaic patterns thanks to the concepts of feminist narratology, a language for articulating new ways to represent and represent women's realities through narratives.

The positions and fears of women in society are represented through the creation of characters like Amy and Isabelle, and writers' integration of narratological concepts provides a stronger connection with readers, not entirely found in previous works in these genres, that mirrors feelings and conditions experienced by women in contemporary culture. The evocative power of female writers is almost vernacular when creating these worlds – they utilize these writing practices to deal with new conditions, real and fictional, to provide new spins on the genre that many readers nowadays might feel.

*Gone Girl* and *The Tiger Flu* are hardly the beginnings of feminist writing in genre fiction, nor are they the final word in this sphere of women's writing or the only thing to reinvent them, but feminist narratology works positively in their regard. Narrative strategies, female characters, and tropes can all combine to deconstruct the gendering their genres seem ideologically bound to. These works, while different in genre, scope, and narratives, are similar in the way they take tropes from their male-dominated genres and subvert them in criticism of the ideological systems that unfortunately bind them.

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# THE CEREBRUM OF CULTURE: A HISTORY OF AMERICA AND TELEVISION FROM 1980-PRESENT

Karenna Blomberg

*ABSTRACT: What is the actual impact TV has had in this ever-evolving, modern entertainment landscape? Has this impact changed or lessened over the years? Television programming has made many cultural contributions from the small - like the hair and fashion trends inspired by “Friends” in the 1990s - to the more significant - like the growth in popularity of dark and dramatic TV (ex. “Breaking Bad,” “Game of Thrones”) corresponding with the death of the concept of the nuclear family and other similar cultural norms in the late 90s to early 00s. This is particularly important to demonstrate in an age in which television programming is considered to be a fairly unstable medium, torn completely between streaming and broadcast. TV has had strong influences over other mediums of culture; films, books, even future generations of TV, as well as influence over the American way of life. However, the reverse is also true; American culture, in many ways, has controlled the specific directions TV has gone in, with fan engagement being important to the future of a show in much deeper ways than any other medium. In fact, since shows like “Hill Street Blues” kicked off the redefinition of the drama in the 1980s, television and American culture have had an incomparable and crucial connection of immediate influence and imitation in ways both minute and great.*

## Introduction

Ask a hundred people for their thoughts on television, and you’ll get a hundred different opinions. Some may laud it for its ability to easily entertain, and others may criticise it for the same. TV has created trends and swayed opinions; it has the power both to unite and to divide. It is praised both for having a fresh, diverse range of programming, with plenty of representation for minorities and for having new, creative takes on storytelling concepts. And yet TV is still rebuked for being an “old hat” a dying art doomed to drag along in the footsteps of tried and true media like film and newer, showier ones like social media. In spite of this, especially in the U.S., TV has established a firm grasp on the culture in a way that other art forms have and—frankly—cannot. TV has had strong influences over its fellow media including films, books, even future generations of TV, as well as influence over the

American way of life. However, the reverse is also true; American culture, in many ways, has controlled the specific directions TV has gone in. In fact, since the redefinition of the drama in the 1980’s, television and American culture have had an incomparable and crucial connection of immediate influence and imitation in ways both minute and great.

“Culture” is a term that encompasses all behaviors, ideals, and intellectual and physical expressions that make up the social framework of a certain community. American culture is stereotypically stapled by imagery of flags, burgers, stars and stripes. But just as any other general public, it is much more intricate of a system than it is portrayed. Even with this in mind, it is difficult to pinpoint exactly what can be identified as “culture,” and what’s more, what can be seen as distinctly “American.” This paper will utilize a rather broad definition of “culture” as a term representing the retrospective general

consensus of the American people on social norms and ideals during a certain time period. Adopting a broader idea of “culture” will also help to demonstrate the wide reaches of Television on various aspects of American life as a whole.

## The 1980s: A New Form of Television

When the 1980s began, TV was reaching horizons never seen before. After years of family-friendly comedies and westerns, the popularization of dramatic comedies such as

*M\*A\*S\*H* and action shows like *Charlie's Angels* in the 1970s began to give TV a new stylistic wind. By 1985, dramas such as *Hill Street Blues* and *St. Elsewhere* were just as popular as the sitcoms that had previously dominated the airwaves (Holloway, 1989). Both daytime and primetime soaps gained major followings, and cable TV began to pick up steam as HBO introduced original content in the form of *Tales from the Crypt*. These major changes are what identified the decade as the “redefinition” of TV (Allen & Thompson, 2009).

## Influence of Culture on TV: Revolutionizing the TV Drama

In the 1950s and 1960s, TV programming was not designed with one particular audience demographic in mind. Families most often watched TV all together, meaning that content was made so that it could be consumed by anyone (Gay, 2001). In the 1970s going into the 1980's, programming styles began to shift, as a few shows specifically written for adults began to debut. These “adult” shows quickly boomed in popularity; *Hill Street Blues* is the most popular example of an 80's show with a premise that was distinctly adult-oriented. Additionally, shows such as ABC's *Moonlighting* and *Roseanne*, and CBS's *M\*A\*S\*H* directly utilized mature themes and content, addressing weighty existential concepts, or serious issues such as PTSD and morality (Gay, 1993; Patterson, 2017).

Jointly related to this shift in content, in the 1980s, networks began to pay more attention to ratings. While the Nielsen Company had been taking rating statistics for 30 years, the 1970s was when networks really began relying on this data to make renewal and cancellation decisions. It was then determined that 18-49 year-olds, as the most marketable demographic, were the only important demographic to produce for. It was at this point that “the demo,” as a concept, was born. This demographic soon became a more important factor in renewal decisions than actual ratings (VanDerWerff, 2018). The concept that “only viewership from younger adults matters” can be seen as both a result and proliferation of many societal problems prominent in the 80s, including American idealization of capitalism and the cultural invalidation of elders and minors. The birth of the demo also marked the high level of influence that Americans had on TV as a medium specifically; book and movie ticket sellers generally did not closely regard the particular demographic that purchased their product, but TV producers did. By the 80s, TV was much closer to the hearts and homes of the American public than any other medium, and the introduction of the demo cemented this.

The shift of attention to ratings and the demo is likely one of the single-most influential changes in the history of television programming, and the results of it were divisive. For the most part, the focus on pandering to one specific demographic allowed TV to quicken a process that diversified the types of content put on TV. With the change, shows began to address more serious matters, expand on their use of curse words, sexual content and violence. TV writers were, for the first time, able to break the mold pressed upon production because of the content's general audience. At the time, this expansion on content was not particularly welcomed by many critics; it was met with skepticism and even condemnation by some (Quill, 1989). However, in perspective, the use of the demo was the first major domino to fall that would turn TV into the distinct art form it is today.

Unfortunately, the effect culture has on TV is not always for the best, and the newfound centrality of the demo came with its downsides. Advertisers' focus on a specific demographic did open new avenues for TV to operate in, but it also forced it into a situation in which all programming was bridled by cash in more ways than before. TV was (and in many ways still is) the only artistic medium that cannot be distributed independently, and it is because the sole success measure for a television series is the producing network's cost vs. benefit, as opposed to quality, potential, or fan engagement. While the sudden import of the demo allowed 80's shows some creative freedoms, it also forced all content put on the air to fit with the wishes of the advertisers, whether or not those wishes actually matched with those of the public (Storey, 2009). This would remain a major issue for many years, especially as large fandoms grew around TV shows that did not necessarily meet advertisers' standards, causing a kind of impasse that would always result in the networks siding with advertisers over the viewers.

### **Influence of TV on Culture: Cult Followings and the Television Event**

Because the TV networks began to cater to a single demographic, the 1980s marked a major change in the style of programming. While a few had been introduced in the mid-to-late 70s, the 80s were when drama shows and "cult" shows (a general term here used mostly to refer to satires and dramedies with unique or fantastical elements, à la *Moonlighting*) burst onto the scene (Allen & Thompson, 2009). *Hill Street Blues*, in addition to being one of the first TV police procedurals, was widely praised for addressing sensitive cultural issues, especially those surrounding the police. *M\*A\*S\*H*, which ended in 1983, had been doing similar things as pertaining to the military, but the major distinction between the two was that *Hill Street* was not marketed as a comedy, but as a drama (O'Connor, 1981). On all avenues, TV was stretching its creative wings.

*Moonlighting*, when it debuted in 1985, was not pegged to be the show to forever change the TV landscape. However, the detective comedy, starring Bruce Willis and Cybill Shepherd, was so embrasive of the newfound creative liberties available to it that it ended up breaking almost every established rule and stereotype, and established new tropes still common today. *Moonlighting* prided itself on the meta; the characters often recognized that they were a part of a TV show and skimmed their fingers along the metaphorical fourth wall. In fact, *Moonlighting* is often attributed to influencing the institution of musical episodes, themed episodes, Black and White episodes, satire and parody episodes, and more (Clark, 1989). Because of this, most credit it as the origin of the modern concept of "cult" TV, as well as providing ample inspiration to the creators of many fantasy, sci-fi, and cult shows that would have their own cultural impact in the future. The major impact of cult shows would not be felt right away, but after the internet broadened the availability of the niche to the public, the genre would end up radically shifting cultural mindsets.

While *Moonlighting* exemplified the cult hit, the 80s were also a time for the major "television-event." From its inception, TV had always been the host for "events" that drew massive viewership. However, before the 80s, these were typically televised versions of live events, such as the Coronation of Queen Elizabeth II or the Oscars. In 1980, *Dallas* changed that, when they aired an episode that concluded a previous season's cliffhanger, the now-famous resolution to "Who shot J.R.?" Adweek later claimed this episode attracted more than 80 million viewers (Patterson, 2017). *Dallas* and "Who Shot J.R.?" can still be recognized as one of the most historically significant events in television programming history. Years before television "fandom" and binge-watch culture became normalized, major TV events were fewer and further between, but had a much higher impact. "Who Shot J.R.?"— as the most

notable of these—proved that the stories on TV in themselves were worthy of “event” status in the same way as political or cultural events.

One year after *Dallas*, *General Hospital* perpetuated the TV-event, with their episode featuring the wedding of Luke and Laura, two of the most popular characters. This episode was estimated to have attracted upwards of 30 million viewers and is still regarded today as possibly the quintessential moment in soap opera history. Few TV programs afterward ever reached that level of engagement, but regardless, both of these episodes marked a specific moment in time when TV shows became important enough culturally to have an intrinsic sense of merit (Gillis & Jennings, 1999). Suddenly, television itself was remarkable enough to the general public that an event happening in a TV show was a cultural event in itself.

## Summary

The massive shifts in production and distribution decision-making that occurred in the 1980s changed the way TV was made and the way it was consumed. Many believe that the 80s was a “New Golden Age” for television content, and it is widely agreed that this decade is directly responsible for all programming that came after it. The 80s introduced the modern drama, popularized the “adultification” of TV content, and planted the seeds for many highly influential shows to come. It was the first decade in which TV became a medium recognizable for its own uniqueness, and it paved the way for TV shows to be seen as an art form on the level of traditional film.

## The 1990s: Something for Everyone

In the 1990s, the segmentation of TV genres that began in the 80s came to its fulfillment. The 90s was marked by the growing popularity of more niche shows, like *The X-Files*, *Xena: Warrior Princess* and *Twin Peaks*. Shows marketed to teens such as *Beverly Hills, 90210* (at the beginning of the decade) and *Dawson’s*

*Creek* (near the end) gained large followings as well. With the exploding popularity of *Seinfeld*, live-audience sitcoms experienced a major renaissance, and shows like the aforementioned *Seinfeld*, *Friends*, and *Sex and the City* honed a new subgenre: the “single friends living in the big city” comedy (*Standup to Sitcom*, 2014). In all, the reinterpretation of old genres and the growth of new ones made the 1990s an interesting transitional period in TV production as the landscape shifted from the formation and aesthetics of the 20th century to the ones we know today in the 21st.

## Influence of Culture on TV: Dysfunctional Families and Fragmental Genres

The same decade that the existence of dysfunctional families became a normalized occurrence in wider American culture, TV programs also began to break down the “perfect” family dynamic. Echoing this, the fragmentation of genres that emerged in the 1980s continued into the 90s, to the point that each family member had a different show to watch (“Understanding Media and Culture: An Introduction to Mass Communication,” 2016, p. 366). There were still family sitcoms, like *Full House* and *The Fresh Prince of Bel-Air*, but they now were geared towards younger audiences. “Teen” shows were generally very closely related to primetime soaps in that they used romance and shocking plot twists to uphold the main storyline of the show, but they still often featured elements of children’s programming such as episodic life lessons. “Adult” shows became the most radically distinct new genre of the era. 90s comedies began utilizing divisive jokes, dark humor, and - instead of upholding the ethical and politically correct - often glorified the morally disturbed protagonist. Similarly, dramas used a significant amount more of sex, drug use, and violence than was allowed in previous years (Allen & Thompson, 2009)

Family sitcoms in the 1990s were one of the greatest examples of the great dissonance

growing between different audiences – and Americans as individuals. What had once been portrayed as viable entertainment for any age group was now mainly marketed towards children and young families. The great majority of these shows tried to address common topics faced by younger viewers, such as bullying and peer pressure, and emphasized family unity and good morals as designed for an elementary to middle school-aged consumer. For example, *Saved by the Bell* often discussed dating and relationship issues, and *The Fresh Prince of Bel-Air* famously addressed dynamics of broken families.

One of the longest-staying of these 90's "kids" shows was *Full House*, an ABC sitcom that aired from 1987-1995. Surrounding a single father raising his three daughters with his best friend and brother-in-law, *Full House* was a major success in the 1990s but it is possibly remembered best for its family-oriented messages; the show seemed to understand its integral place in children's lives, and therefore much of the show was in some way positively messaged or educational. This not only benchmarked the divorce of "kids" programs from general programming, but also showed another result of the breakdown of the nuclear family; TV was not only an entertainment source for kids, but a new parent, a secondary or even primary source of information on how the world works (Endrst, 1994).

Unlike family shows and adult shows, teen shows essentially did not exist before the revolutionization of the drama. Then, in the late 80s and early 90s, shows began cropping up that were specifically marketed to high schoolers and college-aged adults, possibly in an attempt to pull in more of "the demo." In 1995, Warner Brothers launched The WB, a broadcast channel with a teen/young adult audience in mind. These teen shows were written as a kind of smorgasbord of elements borrowed from other genres already popular. They often had specific messages woven into episodes like kids' shows,

but they also tended to emulate primetime soap operas, in that they relied heavily on scandal, relationships, and left-field plot twists to engage viewers. This "middle-of-the-road" approach appealed to young adults, and teen shows grew quickly in popularity.

Consequently, by the late 90s, the TV market was flooded with shows marketed to teens and young adults (Thompson, 1999). Shows like *Buffy the Vampire Slayer*, which blended the teen and cult aesthetics, represented an even greater change in TV's relationship with its viewers. Following a teenage girl attempting to balance high school life with her secret role as a force against various evils, it helped launch a "supernatural teen" subgenre that is still very popular to this day. In addition to being the model of the 1990's teen show and the blueprint for future teen programming, *Buffy* was also often singled out for representing the modern feminist movement in its earlier stages. Before representation in media was widely demanded, *Buffy* provided it, and the titular protagonist is still seen as a major feminist icon (Reid-Walsh & Walsh 1999). *Buffy*, and many shows like it, served as a way to generate respect for the TV genre, beginning in niche fan communities. Its devotees – among them, future *New Yorker* TV critic Emily Nussbaum, who said the show was "...[S]omething that I wanted to discuss with anyone, whether they liked it or not," (Nussbaum 2019, pg. 9) — considered it an art form worthy of analysis. Fans' viewership of the show was not so much a hobby as it was a distinct aspect of their life – TV fandom was seeping into viewers' personalities and becoming a legitimate part of their identities.

The speedy separations in youth versus adult content came at a time when family dynamics were rapidly changing as well. In the 1980s and going into the 1990s, adults were getting married less and later, divorcing more, and choosing to remain single in favor of career-building (Johnson, 2000). Children gained independence and teenagers gained autonomy;

hence, each group got their own type of show to consume. TV show characters also exemplified the concept of a “nontraditional” home; *Full House* showed a single father raising his kids on his own, and *The Fresh Prince of Bel Air*’s main character had an absentee father. The many iterations of this cultural concept of familial diversity and independence would continue to grow in the 2000s and 2010s, as did its role on TV.

These new American values permeated all of TV in the 1990s. The “single friends in the city” premise in sitcoms was a perfect blending of the dreams and realities of the Gen X-ers reaching adulthood in this era. Various other genres of show that also began to gain steam in the 90s also echoed the interpersonal trends of the day. *The Simpsons* parodied the concept of the nuclear family, and comedy-dramas like *Ally McBeal* and *Murphy Brown* highlighted the “independent single businesswoman” in conjunction with the rapidly growing number of women in the workplace. *Buffy*, as well as similar teen shows like *Felicity*, also highlighted female independence, and shows like *Party of Five* also turned traditional family stereotypes on their heads.

## **Influence of TV on Culture: Influence on Everyday Life**

After the unexpected success of *Moonlighting*, more and more networks became interested in creating similar content: wacky, oddball and meta, and yet with strong elements of seriousness and drama. This new “cult” genre manifested in many different ways over the years. Although *Moonlighting* was a mystery show, its style mostly rubbed off on a different genre, helping in its revitalization: sci-fi and fantasy. *The X-Files*, *Buffy the Vampire Slayer*, and *Xena: Warrior Princess* all inherited the lighthearted, not-quite-serious tone of *Moonlighting*, and built upon it. This helped to lay the framework for nerd culture to become mainstream in the late 2000s, and later morph into the fandom culture of the 2010s.

The 1990s were also a notable time in which the fashion seen on TV began to break its way into the mainstream, especially among teenagers and young adults. Likely because TV-watching was becoming more routine for these younger generations, the source of many of these trends came from teen shows such as *My So-Called Life* and *Buffy the Vampire Slayer*. However, the one show that most affected the culture and style of the 1990s was not a teen show, but *Friends*. The wardrobes of Phoebe, Monica and especially Rachel single-handedly drove many 90’s trends and today is still looked to when reflecting upon the 1990’s style aesthetic (Critchell, 2001).

The proliferation of TV in everyday style was not kept only to fashion, however. The 90s were also a major time when terminology and quotes from TV notably began to leak into American culture. Quotes that many considered funny, such as *Seinfeld*’s “No soup for you!” became popular references to make. Additionally, TV shows created phrases that became known outside of the “sphere” of popular culture. *Friends* alone is credited as either coining or popularizing the terms “BFF” and “the Friend Zone” (Buchler, 2014). The term “regift” can be traced back to a 1995 episode of *Seinfeld* (Abadi, 2018), and the popularization of the exclamation “Woah!” in its current most common context is often attributed to *Blossom* (Highfill, 2013).

## **Summary**

In the 1990s, Americans were beginning to accept television programming as a cultural mainstay. TV shows were no longer just engaging - they were educating people’s children, informing their opinions, and changing small but significant aspects of their everyday life. TV’s major role in domestic life continued on, even as the decade saw the breakdown of stereotypes regarding domesticity. TV has always been unlike any other medium of entertainment that preceded it because of its specific ability to adapt and change its method of storytelling to meet cultural desires. However,

in the 1990s, TV began to prove in many ways that it itself could be influential on the direction of popular culture.

### The 2000s: TV as Art

In the 1980s and 1990s, TV was becoming cemented as an entertainment form. Content diversified with the culture and watching TV habitually every night became common practice. The 2000s, though, was when TV changed in essence. With the dawn of cable TV programming, the TV show became not only an entertainment source, but an art form. Dramas evolved from the soapy, over-the-top style of the previous decades to structured, serialized stories with stronger ties to realism. The antihero protagonist boomed in popularity and audiences began to seek more “relatability” and emotional honesty in both their comedies and dramas.

### Influence of Culture on TV: Realism and Fanaticism

Much of the influence of American culture on TV in the 2000s is closely tied to the millennial generation. While not the first generation to grow up watching TV, those born in the 1980s to the 1990s were the first to grow up with the new, “revolutionized” form of television - after the mass introduction of cable. Additionally, as mentioned, children of the 90s grew up during the deterioration of the stereotype of the nuclear family, which often resulted in children consuming more TV on average. With this generation now reaching adulthood (and becoming a part of “the demo”), TV became more catered to their preferences. Having grown up with TV as such a large part of their life, and with many considering it more than just a source for mind-numbing entertainment, millennials called for a stronger reflection of reality on their TVs.

The resulting realism trend is apparent everywhere in 00’s programming. Looking at the most popular TV shows from 2000-2009 in comparison to those from 1990-1999, one

would find near opposites in terms of content. In the 90s, there was a proliferation of soap-like dramas such as *ER* and *Beverly Hills 90210*. These shows portrayed likable, charming leads dealing with highly exaggerated dramatic situations. However, as the world moved into the 21st century, most shows began to turn dark and gritty. *The Sopranos*, *The Wire*, and *Breaking Bad*, three of the most popular programs of the era, all starred a morally questionable ensemble of characters, and featured many dark, graphic scenes and plotlines (Sohn-Rethel, 2015).

Interestingly enough, even comedies of the 2000s closely followed the “realism” trend. The general popularity of comedy in the new millennium plummeted down, especially compared to the sitcom-renaissance that occurred in the 90s. After *Friends* ended in 2004, the “live audience” genre of sitcom all but died off, with few other attempts breaking into the popular, besides the occasional *How I Met Your Mother* or *The Big Bang Theory* (Allen & Thompson, 2009). What replaced the “live audience” comedy was a brand of sitcom that had gone essentially unseen on American TV previously. The first of this new kind of sitcom aired in 2003, with FOX’s *Arrested Development*, a show that broke from the formulaic nature of most comedies of the day. While the show was majorly popular with critics and viewers, the network saw its very specific humor style and heavy use of inside jokes as polarizing to the casual audience, and cancelled it after only three seasons (Poniewozic, 2013). However, in 2005, NBC tried their hand at a similar format to *Arrested*, releasing a show that would continue to dictate the norm for TV comedies for the next decade, and have an enormous impact on American culture as a whole for decades to come.

Drawing on the dry, awkward situational humor that had long been popular in the UK (and, in fact, based on a popular British show of the same name), *The Office* single-handedly launched a new subgenre of TV comedy

into the limelight: the mockumentary. The show followed a goofy cast of office workers in a drroll paper company, under the guise of a “documentary” about the branch. This documentary plot element allowed the show to translate many techniques to comedy that had not generally been used on American TV before: talking heads; long silences; characters looking directly into the camera in opportune moments. A perfect example of the decade’s realism-mania, *The Office* did not source its comedy in individual jokes as much as it did in bits, placing its ensemble of characters (written to represent subtly heightened versions of office stereotypes) into awkward, uncomfortable, and strange situations. Most of the popular comedies of the rest of the decade closely followed *The Office*’s model, utilizing heightened stereotypes, clashing of diverse ensembles, and talking head cutaways to affect comedy. While many of these, such as *Parks and Recreation* and *Modern Family*, received much acclaim, none surpassed the popularity of *The Office*, and none have stayed as culturally relevant even six years after its finale. As of 2019, *The Office* alone took up a whole 3% of Netflix’s viewership per year (Saraiya, 2019). What cult shows in the 90s started, *The Office* perfected, creating a cultural phenomenon that is uniquely pervasive in the everyday life of Americans.

Another thing that largely affected TV in the 00s was fan engagement. Prior to the development of social media, the only real sources of reception for any given show came from ratings and critics. However, in the 2000s, as blogs and internet chatrooms became widely used, and later, social media platforms such as Twitter and Facebook, there was suddenly a new source of feedback for media makers: fans. In the 00s, interactions with creators and fellow fans suddenly became free and easily accessible, and fan communities wasted almost no time in making themselves heard by showrunners.

This intense new form of feedback in the 00s was critical in the success (or failure) of

shows such as *Supernatural* and *LOST*, but it also marked a time in which factors other than money, ratings, or criticism contributed to a major cancellation/renewal decision. One example: in 2009, *Chuck*, a spy comedy with a loyal fanbase, was looking more than likely to be cancelled. However, a vocal fan campaign on social media gained so much attention that NBC decided to renew it. This renewal decision proved that the internet had given fans a new sense of ownership of TV programming, a fact that has only grown truer over time (Carter, 2009).

While fan engagement and the internet changed a lot about television, there is one aspect of TV that barely shifted at all from the 90s to the 00s. While the most popular styles of programming changed drastically on TV in the 2000s, the teen genre, perhaps because of its novelty, remained mostly the same. Soapy high school dramas like *The O.C.*, *One Tree Hill*, *Gossip Girl* and more thrived within the teen niche, gaining fervent followings and becoming some of the most popular shows on TV. However, the most lasting impact on culture from the teen genre would come from a less conventional place.

Following in the footsteps of fantasy shows such as *Buffy* and *The X-Files*, *Supernatural* - which began on The WB in 2005 - would leave its mark on American culture in unexpected ways. Following two brooding brothers road-tripping across the country hunting demons and monsters, *Supernatural* played off of the popularity of magical, supernatural and dystopian teen-oriented fiction of the decade. While not, in itself, particularly remarkable from many other *Buffy/X-Files* follow-ups of the day, the allure of the show’s premise allowed it to quickly gain an almost ravenous fanbase. Using the internet as a tool, *Supernatural* fans discussed the show, set up conventions, made videos and art in appreciation of the show, and published fanfiction. In this, *Supernatural* In all, with the start of a new millennium, both TV

and American culture swung wildly away from anything they had previously been. Growth of the millennial generation led to major changes in the way TV was presented. Because of this, the familial ties between TV and culture were becoming more and more clear. Even though dramas and comedies completely changed direction while the cult and teen genres remained mostly the same, all of their influences combined to inform the future of American culture in ways both direct and drastic.

### **The 2010s: The “Peak TV” Era**

The 2010s was marked by an overflow of TV content. As streaming services grew into vogue and began releasing original content, the rules of the television game changed forever. As more and more streaming services emerged with fresh, innovative content (and networks scrambled to update and improve their own programming to fight the influx) TV shows rocketed in not only quantity but quality. Because of this, the era beginning in the 2010s has been referred to by many television critics as the “Age of Peak TV.” In addition to those changes, the 2010s also saw the rise of a “Nostalgia Era” of TV, featuring many shows purposefully reminiscent of the 1970s, 1980s and 1990s as millennial filmmakers paid tribute to the culture of their childhoods.

### **Influence of Culture on TV: Nostalgia and the TV/Social Media Relationship in Action**

In the late 2000s and early 2010s, millennial filmmakers began to break onto the TV scene. Along with them, they brought a sense of nostalgia for the decades they grew up in, leading to a large amount of new content set in the 80s and 90s. In the 2010s, the late 1900s in general was nearly a more popular setting for new TV shows than modern day. Dramas like *The Americans* and *Stranger Things*, and comedies like *The Goldbergs*, *Fresh Off the Boat* and *GLOW*, among others, all portrayed vastly different takes on the same two decades. This trend is part of a larger movement of the 2010s

loosely coined “The Nostalgia Era.” Coming mainly from the reminiscences of millennials on the culture of their childhood, many elements of the 80s and 90s returned into vogue. This concept in itself is not revolutionary - culture is naturally somewhat cyclical. However that cycle, for the most part, had never really applied to TV, and certainly not at the magnitude of that which occurred in the 2010s. The internet is a likely culprit for the proliferation of these trends beyond that which was previously normal; all the shows, movies and music from the 1980s and 90s were easily available for consumption (Lizardi, 2014).

Another manifestation of the nostalgia era was the culture of reboots that emerged in the 2010s. While the TV reboot had conceptually existed for decades, the 2010s saw a major influx of reboots and remakes, especially of shows that were popular in the 80s and 90s, and even the 00s. Several shows from those years now got “sequel” shows that continued the story in some way, including the aforementioned *Arrested Development* and *Full House*. New shows also emerged in the 2010s that were remakes or continuations of popular 80’s and 90’s movies, including *Lethal Weapon* and *Training Day*. Finally, other shows got total reboots with brand new stories, such as The CW’s *Charmed* and *Dynasty*. By the end of the decade, almost every popular show of the past 30 years had been at least considered for a reboot. Many believe that it came from a lack of creativity, but a more accurate statement would simply be that it comes from the newfound easy access to things from the past, thanks to the internet.

If the 2000s introduced the world to the wonders of the internet, the 2010s, in many ways, introduced it to the horrors. One of the major displays of these “horrors” involved politics. The mid-to-late 2010s in America were marked by political tension and cultural division unlike that which had been seen in decades, if not centuries, and this division was echoed on TV as well. After the election of Donald

Trump as president in 2016, many shows began “taking sides” in the political turmoil, and many shows began to show a strong liberal bias or began to feature storylines associated with liberal ideologies, although the strength of political commentary differed from show-to-show. *Supergirl*, in 2017, aired an episode entitled “Nevertheless, She Persisted,” a nod to a feminist phrase popularized after Democratic senator Elizabeth Warren was silenced in opposition to the confirmation of Attorney General Jeff Sessions. *SNL*, flailing in ratings after the departure of most of their heavily popular mid-2000’s cast, found a resurgence in popularity when Alec Baldwin began making regular appearances in sketches parodying the then-president-elect. Many 2016 and 2017 shows even devoted whole seasons and entire premises to political subjects; *American Horror Story* aired an entire season surrounding the 2016 election, and *The Handmaid’s Tale*, a dystopian show with strong pro-feminist themes, won the Emmy for Outstanding Drama in 2017 (Ali, 2017).

Not all shows that took political stances leaned left, however. *Last Man Standing*, a long-running ABC sitcom starring Tim Allen, and the 2018 revival of *Roseanne* both featured main characters that were proudly conservative. However, ABC cancelled both shows, both for reasons that were interpreted by many as political. *Roseanne*’s cancellation was based on a public Twitter tirade star Roseanne Barr embarked on that many considered to be offensive. However, *Last Man Standing* did not have an official reason for its cancellation; the show had an avid following, and performed decently in ratings, leading many (including Allen) to allege it was because of the show’s conservative protagonist and themes (Schwartz, 2017). All of these examples show how much the dominant hegemony in America had a throttle on TV programming - something that comes for better or worse.

However, one thing that widespread social media did provide was a new avenue for fans to rebel against elite decisions, which they used to their advantage, including in terms of TV. One of the most undeniable pieces of evidence proving the TV and culture’s firm and still-growing connection came as a result of the 2018 cancellation season. Before the 2010s, a TV show having a life beyond cancellation was practically unheard of. Upon occasion, a popular show from decades past would receive a revival, and rarely, another network would pick up a show after one network cancelled it. Beyond that, however, cancellations were fairly cut-and-dried.

2018 was a particularly dark year for TV cancellations; 61 shows were cancelled overall - 20 of those in a single day - including a number of established fan-favorites (Carras, 2018). Coming off of the viral success of a 2017 campaign to save the cult-hit *Timeless*, creators, fans and stars of many of these shows wasted no time in reaching out to networks to convince them to save their shows. The most vocal of these campaigns, by far, was for *Brooklyn Nine-Nine*, a police procedural comedy on FOX. Fans and actors alike loudly voiced their protest on the show’s cancellation, begging both FOX and Hulu (who had previously saved FOX’s *The Mindy Project*) to give the show another season, to which both networks passed. Finally, only about a day after it was first cancelled, NBC picked up the show for a sixth season.

Fans of other cancelled shows, now encouraged, caused a repeat of this event several times in the next few weeks. *Designated Survivor* was cancelled by ABC and picked up by Netflix; the aforementioned *Last Man Standing* was cancelled by ABC and picked up by FOX; *Lucifer* was cancelled by CBS and picked up by Netflix; *Timeless* was cancelled by NBC again, and once again brought back, this time in the form of a TV-movie. The fight to save *Brooklyn Nine-Nine*, however, was most remarkable, simply because of scale: “#SaveB99” was a

trending topic on Twitter for nearly the entirety of the time the show was cancelled. A coalition of celebrity-fans of the show - including the likes of Guillermo Del Toro, Seth Meyers, Mark Hamill and Lin Manuel-Miranda - loudly voiced their disapproval of the decision, and even dubbed themselves “The Guardians of the Nine-Nine” (McKee 2018). This flood of TV resurrections even flowed into the 2019 season, with many networks refusing to cancel low-rated fan-favorites, and even having to release statements that they would not reverse cancellation decisions (Lenker, 2019).

The Nostalgia era, the political craze, and the 2018 show resurrection all connect in one very clear way: they’re all undeniable proof that, now more than ever, TV is listening to its fans - and when most of their publicity comes through social media, they have to. Television has always been strongly tied to American culture, but one of the interesting benefits of the internet age is that it can now be directed by it.

One final example of TV’s response to culture in the 2010s was the dramatization of the TV comedy. While the introduction and popularization of heavy, dark dramas happened in the 1990s and 2000s, the thirst for more quality dramas carried on so prominently into the 2010s that comedies began to evolve to fill the void. By 2015, the comedy style made famous by *The Office* ten years earlier no longer floated in most cases. ABC did notably have some hits in the form of *Black-ish* and *Fresh Off the Boat*, and a few shows that debuted in the 00s, like *Parks and Recreation* and *The Office* itself, were able to successfully wrap their runs. Other than these rare examples, TV comedies found themselves in an awkward transition point. Comedy had, for a moment, flailed, but was soon reborn - as drama.

While dozens of previous comedies had blended comedic and dramatic elements, 2013’s *Orange is the New Black* on Netflix was one of the first to embrace the comedy-drama

as a true genre. Based on the biography of an inmate in a women’s prison, the show mined the comedic personalities of its ensemble of female prisoners, while also honestly and at times brutally portraying the seriousness of the characters’ situation. *Orange*’s commitment to being both dramatic and comedic broadened the horizons of what a comedy could be, as well as blurring the lines of what a comedy was. *Orange*, however, was only the beginning of the comedy-drama revolution; soon, dark comedies and comedy-dramas were cropping up in droves, especially on streaming services and cable channels, which, of course, had looser content restrictions. Some of the most successful comedy shows of the 2010s were these comedy-dramas, including FX’s *Fargo*, HBO’s *Barry* and The CW’s *Crazy Ex-Girlfriend*. Many shows were also quick to emerge that played with the concept of a comedy-drama; The CW’s *Jane the Virgin* loosely marketed itself as a comedy soap, and Netflix’s *A Series of Unfortunate Events* was a comedy-drama for families. This comedy-drama revolution even began to touch “regular” comedies. The 2010s saw many network and cable comedies, like, *Office* writer and producer, Michael Schur’s *The Good Place*, eschew the episode-to-episode plot format used by nearly all comedies at the time, in favor of a more serialized storyline style previously only favored by dramas. All this acted as a remnant of the realism trend from the 00s, as a new generation of filmmakers sought to put their own views of the world more clearly onto the TV screen (in this way allowing it to more closely imitate other visual art media, such as film).

### **Influence of TV on Culture: Netflix and Nerd Culture**

The most prominent way that TV influenced culture, not just in the 2010s but possibly since the reinvention of the drama, was through the introduction of streaming services. In 2007, Netflix, previously known for renting out DVDs to consumers, announced the launch of

a streaming service, where certain shows and films would be available to watch online, free for Netflix subscribers (Helft, 2007). It wasn't until 2013, however, when Netflix released its first original programming, and subsequently changed the television landscape forever. When *House of Cards* came out, it immediately caught the public's attention. With the exception of the occasional, generally low-budget web series, the only place one could go to watch new TV was the TV set. Upon *House of Cards*' success, Netflix was quick to release more original content, and Amazon Prime and Hulu's streaming services, which launched at similar times as Netflix, also began to release original programming.

Netflix's release strategy for its television shows (both original and acquired) was conducive to a new form of TV consumption. Instead of releasing one episode a week, Netflix would release entire seasons all at one time, allowing entire shows to be watched at the leisure of the viewer. "Binge-watching," as it came to be called, involved the rapid, successive watching of entire shows in short amounts of time, and is one of the biggest contributors to American culture in the 21st century (Rattner, 2014). One 2018 poll indicated that approximately 63% of TV watchers ages 18-29 will habitually binge episodes of a series at least once a week (Sabin, 2018).

Binge-watching, as well as the online culture surrounding it, also contributed to a major trend that emerged in the 2010s: the rise of "nerd culture." For a long time, sci-fi and fantasy programming was generally categorized as a part of the "cult" TV genre, much because fanbases of most of these shows were small but vocal. Sci-fi and fantasy shows generally did not get widespread attention, nor consideration during awards season. This all changed with the 2011 premiere of HBO's phenomenon show, *Game of Thrones*. A fantasy drama based on a popular book series by George R.R. Martin, *Thrones* portrayed an ensemble cast of characters in conflict with one another to

win the throne of fictional kingdom Westeros. Famous for its liberal use of sex, violence and plot twists, *Thrones* appealed to casual drama viewers and hardcore fantasy fans alike, quickly becoming one of the most popular series of the 21st century.

*Game of Thrones*' popularity came around the same time as other similar sci-fi and fantasy properties were gaining cultural steam in other media, such as the Marvel Cinematic Universe and the *Harry Potter* series. All of these combined to create a "pro-nerd" cultural environment in the 2010s, which caused a higher supply and demand for sci-fi and fantasy shows, which also began to be commonly seen as their own genre. This later paved the way for highly popular sci-fi and fantasy shows such as *Stranger Things*, *The Flash*, and *The Walking Dead* to emerge to large audiences. What this acceptance of Television "nerd-dom" truly told us, however, is that not only had television completed its 50-year journey from time-waster (think: the "boob tube") to respectable artistic medium. That most people were willing to become intensely devoted to a certain TV show told us that most people thought that TV had something worth investing in.

By the 2010s, current TV was not just affecting culture as a whole; it was affecting the future of media as well. One final thing streaming platforms managed to radically change was the ratings system. Ratings, as mentioned previously, had long been the end-all be-all on the fate of a show. But as streaming services rapidly grew in popularity, this changed as well, for two main reasons.

Netflix, Hulu and Amazon Prime, the three largest streaming platforms, became known for hardly, if ever, releasing viewership data. This gave renewal decisions an air of mystery - and a sense of unimportance. This new laxity toward ratings began to spill over to cable channels as well. The second reason why ratings began to lose import in the 2010s was simply because

fewer people were watching network TV live anymore. Between DVR, next-day streaming on Hulu and network websites, and postseason streaming on other services, networks could no longer accurately gauge the actual level of public interest in any one show (Mitovich, 2017). Sometimes, shows would perform average or below in ratings initially, then gain large followings of people who streamed the show after its first season ended. This was the case for teen cult-hit *Riverdale*, which averaged a 0.5 in the demo in its first season, only to nearly double to 0.8 when its second premiered, likely due to many new fans picking up the show on Netflix over the summer (Otterson, 2017).

In addition to making “binge-watch” a common verb, the 2010s had some of the most direct impact on American communication to date. Stemming from event-like shows such as *Game of Thrones* that many people watched live, the decade saw the concept of “spoilers” becoming a cultural taboo; letting slip major plot twists (or eventually, even minor plot points) began to be seen as especially rude both on the internet and in real life. Much like the 90s, language used in and surrounding TV also became mainstream beyond the platform in which they originated. Terms like “cancelled” began to be used on the internet to refer to people or concepts that were “over” in the public eye, derived from the usage of the term in TV production.

In all, the 2010s were one of the most eventful decades for television since the medium began. Its effect on culture was becoming not only present, but pronounced. Likewise, fans of TV were becoming more and more of an influence on the decision-making both onscreen and behind the scenes of TV. Fans pushing for more representation of minority groups began to be heeded, and genres once pushed aside by networks and advertisers were now on the forefront of popular culture. Overall, the 2010s were a very public age for TV. With high levels of social media scrutiny, the level of TV consumption rising due to streaming services,

and fan engagement meaning more than ever, this decade all but proved that culture and TV were each integral to the development of the other.

### The Greater Question: Is TV Dying?

Ask a hundred people about television, and you used to get a hundred different answers. More recently, however, a lot of people have been beginning to say the same thing: TV is dying. With the dawn of the internet age, average TV ratings have plummeted down on average year-to-year. Studies show that viewers have been spending more time on social media, and less watching network TV than ever before (Guerrero, 2018). A 2009 NPR report depicted the TV industry as standing on failing legs, saying: “It may not be long before broadcasters go back to Congress, hats in hands, looking for a way to save over-the-air television again. Only next time, they may not find one.” (*Analog TV is dead. Is digital TV dying?* 2009). But if TV is so closely connected to culture, how could this be possible?

Most people claiming that TV is dead are looking at TV as the same medium that they have previously experienced. This is not an irrational way of seeing the situation; after all, movies, television’s closest relative, are still composed, criticised and (in many ways) consumed the same way they have been for years. On the other hand, though, TV is a much more fluid art form than writing or movies.

It could also be argued, though, that all mediums, including TV, are connected to culture in the same way. It is true that movies have also impacted culture in many ways, and music has evolved with the changing of culture, and it is certainly true that TV is not the only impactful method of storytelling we have. However, TV is an extraordinarily unique way of telling stories, and that uniqueness lends itself to a closer relationship with the individual than any other medium. Television stories are not bound by time in the way that other mediums are; most

mediums are intended to be consumed over a certain number of minutes, like music, hours, like films, or a certain number of days, like books. TV, however, is meant to be consumed over a number of months, or even years. TV is meant to grow with the consumer, changing in the way that they change, constantly reflecting what they experience.

TV's relationship to us cannot be measured in the same way that other media can. For one, TV is more temperamental; its relationship to consumer reaction is more crucial to its survival than other forms of art. But this special kind of relationship is, in many ways, mutual. If the evolutionary path of TV has shown us anything over the years, it is that there is a growing need for longer, more immersive stories, ones with episodic tropes and boundaries, but that tell a more-in depth, "real" story. Commonly, calling something the "heart" of something else indicates that it is central to the existence of that thing. TV cannot claim to be the heart of American culture - it's still a relatively new medium, having just learned it has any value whatsoever. No, TV is not the heart of American culture. It is too vitally connected to American culture as it is today to be even a heart. TV is America's new brain; constantly receiving input, adjusting to stimuli, forming thoughts, and keeping the rest of the body running subconsciously. And it's not dying - it's thinking ahead; it's planning for the future

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# ANALYZING THE TRANS-HEMISPHERAL MOVEMENT OF *ACIPENSER* SPECIES BY THEIR mtDNA PHYLOGENETIC RELATIONSHIPS

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*ABSTRACT: Taxonomic naming of organisms leads to species which are connected by their evolutionary ancestors. The family of Acipenseridae has existed for over 200 million years through the delicate evolution of descendants. Within this time, the genus of species within it has diversified and spread across the world. Several years ago, however, groups of sturgeons became threatened while others remained relatively stable. This study focuses on the percent of genetic similarity in mitochondrial coding genes for the Acipenser genus of sturgeons, between the eastern and western hemispheres to ask why some sturgeons might be threatened. We hypothesized that our Principal Coordinate of Analysis will show a genetic crossing of the Acipenser species through the mixing of western and eastern species in one cluster. We imported FASTA files for the mitochondrial DNA (mtDNA) of all 17 Acipenser species and sorted the DNA sequences into different protein CoDing Sequences (CDS) in a Python program. By utilizing Basic Local Alignment Search Tool (BLAST), the Python program compared two species at a time to get the percent similarities. With this data, we were able to make a multidimensional scale (MDS) of species similarity using a dissimilarity symmetric matrix. This matrix was then used to create a Principal Coordinate Analysis (PCoA) in XLSTAT. The PCoA plot helped us learn that the species were instead separated into two clear clusters, one of only eastern species and another of both western and eastern species. Our alternative hypothesis was supported, and we note that sturgeons of the Eastern hemisphere, especially the Atlantic coast, appear to crossbreed less often. This might have resulted in lower genetic diversity and correlates with eastern-hemisphere sturgeons being threatened by human and environmental causes.*

*Keywords: Acipenseridae, Acipenser, Principal Coordinate Analysis (PCoA), Sturgeon, Genetic Similarity, Dissimilarity Matrix, Genetic Analysis, Mitochondrial DNA (mtDNA), Phylogeny, Python, Basic Local Alignment Search Tool (BLAST)*

## Introduction

Over the past few millions of years of life, most animals have evolved drastically from their ancestors. Sturgeons have remained relatively like their older ancestors despite many environmental changes and migration events (Rajkov et al. 2014). There are about 27 species given the common name “sturgeon”, all of which fall under the Acipenseridae family in taxonomic naming. While they have evolved without much divergence from their ancestors, recently sturgeons have become threatened or

critically endangered due to ocean pollution or competition by human and other causes (Chassaing, Olivier, et al. 2016). We would like to focus on the phylogeny of these species, so that future research can focus on the genetic loss or fixation of the sturgeon gene pool, which may lead to their downfall. This project studies the Acipenser genus, holding 17 of the common sturgeon species spread throughout the Northern hemisphere (Rajkov et al. 2014). Even with a fossil history containing two of the 17 extant species, the general phylogeny of Acipenser is up for debate because of complicated genetics

and limited specimens to experiment with (Bemis et al. 1997). There is one common phylogenetic tree, but small node switches, like *A. dabryanus* and *A. transmontanus*'s placement in comparison to the *A. stellatus* sturgeon, are still questioned (Rastorgeuv et al. 2008). Through a mitochondrial DNA (mtDNA) analysis of the 17 *Acipenser* sturgeons, we also hope to elaborate on the relative genetic distances of sturgeons.

There has been some controversy in using mtDNA for constructing phylogenies as they do not always match the phylogenies made for nuclear DNA similarities. However, the strength in mtDNA that made us choose it over nuclear DNA was that there is little recombination of mtDNA overtime (David 2005). Since we are also studying at the genus-species level, we can safely avoid homoplasy (where a new trait for a gene arises twice, separate from their common ancestor) that sometimes confuses phylogenies. This allows for more confidence in our PCoA results, assuring us that the similarities are indeed due to common ancestors and not convergent evolution. In our previous experiment comparing sturgeon's entire mtDNA genomes, we noticed that western and eastern hemisphere sturgeons were more like each other than they were to individual hemispheres. Wanting to expand on that, we are now comparing the protein-coding genes of *Acipenser* mtDNA, calculating gene similarity for every combination of sturgeon, and producing a Principal Coordinate Analysis (PCoA) based on their genetic distance for dissimilarity.

For the *Acipenser* mtDNA genome, there are 13 protein CoDing Sequences (CDS) which may differ significantly across sturgeon species (Mitofish 2020). The mtDNA of *Acipenser* species also has 22 tRNA sequences, and 2 rRNA sequences, but we will not be comparing those genes in this study. By comparing similarity (or dissimilarity) between specific protein-coding genes that may have changed over time, we can create a diagram showing how closely related each species is. Our hypothesis is that, as cross-

hemispheric sturgeons are more likely to be related, their genetic distances will be closer and represent one rather than two clusters. This should also suggest that sturgeons have crossed often in their history instead of staying in their relative hemispheres. Alternatively, there is a possibility that sturgeons will be clustered based on their hemispherical location, with western and eastern species being separated into two clusters on the PCoA.

While we could run genome-annotating programs ourselves and sort through the hundreds of combinations of CDS strings per sturgeon, computational biology has made it so processes that take days can be completed in a maximum of five or ten minutes. Our group chose to code a Python program which would splice protein coding genes in each sturgeon genome for us, compare our data in a Basic Local Alignment Search Tool (BLAST), and produce a PCoA displaying their evolutionary distance. Nucleotide BLAST is a handy tool which calculates percent similarity between two strands of nucleotides, while accounting for minor base-pair changes that might normally offset two sequences (BLAST 2020). Python is a programming language that has been a massive help to DNA sequencing and sorting as a high-level programming language (Python 2021). Bioinformatics, a field devoted to programming tools for understanding experimental results in biology, has exploded in the past few decades because of these advantages in saving time and money. With these tools at our reach, we were able to complete the bulk of the project with relative ease.

## Methods

First, we imported all 17 *Acipenser* mtDNA genomes into Python via FASTA files, along with the 17 annotated *Acipenser* files which held the CDS start and stop locations. These locations are defined as the number of nucleotides down the mtDNA where each gene begins and ends. These were acquired through MitoFish's annotator

program, which recognizes the start and stop of each CDS (Mitofish 2020). After each of the start and stop locations were made accessible through Python, we called a method to pull each CDS string directly from the *Acipenser* FASTA files and saved them into a global variable array. This was so they could be used to compare species with nucleotide BLAST.

We used the start and stop indexes given in the annotation files to save each CDS from the *Acipenser* FASTA files, which totals to about 13 sequences. Each of these start/stop indexes corresponded to one *Acipenser* FASTA file. We did this by opening the annotation file to parse, going through each line, and only reading the lines that have the string “CDS” in them (avoiding tRNA and rRNA strings). After we obtained the CDS lines from the annotation, we stored the start/stop integers as indexes. The final step was to open the FASTA file of the species and get the substring using the start/stop indexes, then store the CDS string into the array that holds all the other CDS values. We ran a for-loop on the array to individually collect information such as the start/stop indexes for each CDS before moving to the next sequence in the list. This saves room in the code by repeating the same actions for different items in the array, until each CDS has been accounted for. We printed the array at the end of the for-loop going over all CDS lines, to make sure all sequences are stored in the array correctly.

To compare two of the *Acipenser* species’ CDS, we used the two global variable arrays created by the previous method to save all CDS values. We also invoked BLAST through the Python code we wrote to obtain the similarities of these sequences. First, we created two temporary FASTA files to store the CDS for the two species to be compared. Next, we included the environment variable to make sure that BLAST runs on Windows/Linux. Then, we invoked “makeblastdb” to run all the commands through the .exe file using BLAST. This way, we can run every program through Python

instead of having to use the command prompt. We also have a command that takes a “query” and “subject”, which are the two temporary FASTA files that save the CDS. This command is sent to the system to get a .txt output for the similarity percentage between the two species. We finally close the two files, so that the content can be erased and replaced by the new CDS when the loop starts again through the global variable arrays. A limitation to our current project is due to BLAST for only printing 12 percentages, while 13 should have been seen. All the files consistently had 12 percentages, so we continued with 12 percentages for the results file. In the future, we will fix our code to understand why exactly one gene comparison was missing. To work around this, we took an average of all these CDS percentages for every species and saved them to a .csv file along with the names of the species compared. The .csv file represents a collection of all the species’ average similarity for all their CDS. We ran the program multiple times to test that the .csv file, saved all the correct names of each species, and compared their respective percentages.

Lastly, we chose one species to get the resulting percentages for all possible unique combinations of genetic similarity. We then compared it to every other species in the entire list and ran it until we made every possible comparison. These average percentages are stored in the Supplementary Data 1 file. We simplified the number of combinations to unique pairs by removing the duplicate percentages using the Microsoft Excel function “remove duplicates”. Then, we used these results to create a multidimensional scale (MDS) of species similarity. We converted our data to a dissimilarity symmetric matrix by reversing the percent similarity to dissimilarity and arranged the matrix as seen in the Supplementary Data 2 file. A similarity (or dissimilarity matrix) is a table of all species on both the x and y axis, with their respective percentage of mtDNA genome similarity in each cell that lines up with a species pair. If it is a similarity matrix,

a value of 1 is 100% mtDNA similarity, while a value of 0 means 0% mtDNA similarity. In a dissimilarity matrix, a value of 1 means 0% mtDNA similarity, while a value of 0 means 100% mtDNA similarity. We needed to create a dissimilarity matrix (opposite of what BLAST was outputting) to correctly format our MDS. This dissimilarity matrix helped produce the Principle Coordinate Analysis (PCoA), which is saved in the Supplementary Data 3 file. After running our Python program and comparing each species, we compiled our obtained percent similarity results in Table 1. Then, we created Table 2 by subtracting the percent similarities from 100 to create a difference, or “dissimilarity”, table. Using this difference table, we ran the differences through a PCoA function for XLSTAT to obtain the MDS, or PCoA, graph seen in Table 1. From this graph, we analyzed whether the *Acipenser* species crossed hemispheres once (with two evolutionary distance clusters) or multiple times (with one evolutionary distance cluster).

### Results

We found that for the most part, Eastern *Acipenser* species clustered together, which was represented as Cluster 1 in Figure 1. As can be seen in Cluster 2 in Figure 1, Eastern *Acipenser* species *Mikadoi*, *Dabyranus*, *Schrenckii*, and *Dabryanus* x *Schrenckii* loosely clustered together with Western species *Medirostris* and *Transmontanus*. Interestingly, the Western species *Acipenser Brevirostrum* clustered tightly with the Eastern species Cluster 1 on the left side of the graph. Furthermore, the hybrid species *A. Schrenckii* x *Dauricus* is an outlier, distributed to the bottom right side of the plot. The Western species *A. Oxyrinchus* and the Eastern species *A. Sturio* were outliers while still being grouped together, shown in Figure 1. Overall, we can see that our alternative hypothesis was supported by a clear separation of two species groups, specified as Cluster 1 and Cluster 2 (Figure 1).

### Analysis and Brief Conclusions

Upon analysis of our results depicted in Figure 1, we can glean that the Eastern species were the basal descendants from a phylogenetic perspective due to the tight distribution of Cluster 1. Since *Acipenser* originated in the Eastern hemisphere, we can gather from the data that the Eastern species in Cluster 1 did not cross hemispheres as much, if at all, in comparison to the species located in Cluster 2. However, due to the tight nature of the distribution, we can assume that the Eastern species of Cluster 1 interbred frequently within their hemisphere to the point that their genetic makeup became very similar to one another. The presence of *A. Brevirostrum* in Cluster 1 also indicates a limited trans-Atlantic crossing-over event.

Cluster 2 has a looser and more “mixed” nature of the distribution, in comparison to Cluster 1. This leads us to believe that cross-continental breeding was far more prevalent in the Eastern and Western species belonging to this cluster. This is supported by a simple analysis of the geographic locations of these species. The Eastern species of Cluster 2 are in Russian, Chinese, and Japanese waters, and the Western species of Cluster 2 are located in either the Pacific Ocean or the Western seaboard of the United States and Canada. This is especially true of the Western species *A. Transmontanus*, which resides on the Pacific Coast near California and even as high up as Alaska (*Dershimier*). Although they are from different hemispheres and reside on different coasts, they do share the same ocean.

This relationship between Eastern and Western species in Cluster 2 provides us with evidence to conditionally accept our hypothesis that some *Acipenser* species crossed over often, particularly those near the Pacific Coast (meaning that one cluster is probable). While there are certain cases of crossing-over with *Acipensers* near the Atlantic Coast, those crossing-over events are too few to reliably

accept our hypothesis, and we opt instead to conditionally accept the alternative hypothesis regarding species along the Atlantic Coast.

## Discussion

After getting the results from the PCoA, we noticed that there were some Acipenser species that had significant dissimilarities, one of them being *Acipenser transmontanus* and *Acipenser baerii*, which were on two opposite sides of the PCoA plot and in separate clusters, as seen in Figure 1. In Fiske et. al's (2019) study of determining ploidy in white sturgeon, the study compared entire erythrocyte long-axis lengths obtained using Coulter counter and blood smears to find evolution over time. The flow cytometry analysis from this experiment showed significant genomic differences in the *Acipenser baerii* and *Acipenser transmontanus* species (Fiske et al., 2019). This was found to be true in our PCoA (Figure 1), where we also noticed drastic dissimilarities between the two species compared. Subsequently, this shows that the results we found make sense within the context of this study, where *Acipenser baerii* and *Acipenser transmontanus* are found in separate clusters and found to be significantly different from one another.

Another major pattern we noticed in species similarity was that many of the Eastern Acipenser species were clustered together, as we see in Cluster 1 in Figure 1. We also notice that in Cluster 2 in Figure 1, the Eastern Acipenser species *mikadoi*, *dabyranus*, *schrenckii*, and *dabryanus* x *schrenckii* have a weak and loose clustering with the Western species *medirostris* and *transmontanus*. As for the Western species *A. brevirostrum* located in Cluster 1, we can hypothesize that while it is a Western species, it did not cross over or interbreed as many times in its genetic history as the other Western species, thus maintaining a similar genetic makeup with the other Eastern species of Cluster 1. This is supported by the Bayesian Inference (BI) phylogenetic tree created by Krieger et. al.

(2000) during their study on Acipenseriformes' phylogenetic relationships. In their BI tree, *A. brevirostrum* shares a common ancestor with many of the Eastern species in our study, while the Western species in our study are grouped further down, farther along the tree than *A. brevirostrum*. Another interesting comparison between our studies is that *A. oxyrinchus* (Western species) and *A. sturio* (Eastern species) are depicted in a clade in the BI tree, which explains why these two species are grouped together in Figure 1 of our study.

In Brown et al's (1996) study of length variation and sequence divergence in the mtDNA of four Acipenser sturgeon, the study compared particular protein spots in a species' entire DNA (Li et al., 2010). The results of this research found *A. transmontanus* and *A. medirostris*, which are on the Pacific coast, were more closely related than *A. fulvescens* and *A. oxyrinchus*, which are the Eastern species (Brown et al., 1996). Our results in the Principal Coordinate Analysis showed identical results for the *A. transmontanus* and *A. medirostris* being closer related than *A. oxyrinchus*, which was drastically isolated on the graph. The two separate Clusters in Figure 1 also illustrated significant differences between the two hemispheres and demonstrated crossing multiple times, as shown in Brown's study.

Having an in-depth analysis of the two literature papers mentioned above helped our project in facilitating the analysis of the results we found. Comparing and checking our results confirms our rationale behind them and gives us confidence as to why we got this data from our research on the Acipenser species.

Aside from migration patterns of sturgeons, genetic diversity has been a factor that affects their fitness in different environments (Nelson & McAdam 2012). Our own data revealed *Acipenser sturio* being isolated by almost all other sturgeons besides *A. oxyrinchus*, and this sturgeon is known to have less similarity

(as seen by their mtDNA distance in Figure 1) compared to other sturgeons (Chassaing et al. 2016). They also have competition with *A. oxyrinchus* and have been struggling to spread to other estuaries due to a small genetic pool to evolve from. A similar genetic situation is seen within Michigan sturgeons or *A. transmontanus*. They often stay within their own lakes, revealing dissimilarities within their own species' DNA (Nelson & McAdam 2012). Fewer migrations may contribute to the declining and endangered

sturgeon populations, starting with *A. sturio* and *A. oxyrinchus* in Europe. While not apparent in the stable population of *A. transmontanus*, they are currently in a similar situation, being isolated in the different Michigan lakes, and may follow similar patterns with an unforeseen disaster.

Based on our findings, it may be prudent to research why species along the Atlantic Coast are less prone to crossing-over between hemispheres than species along the Pacific

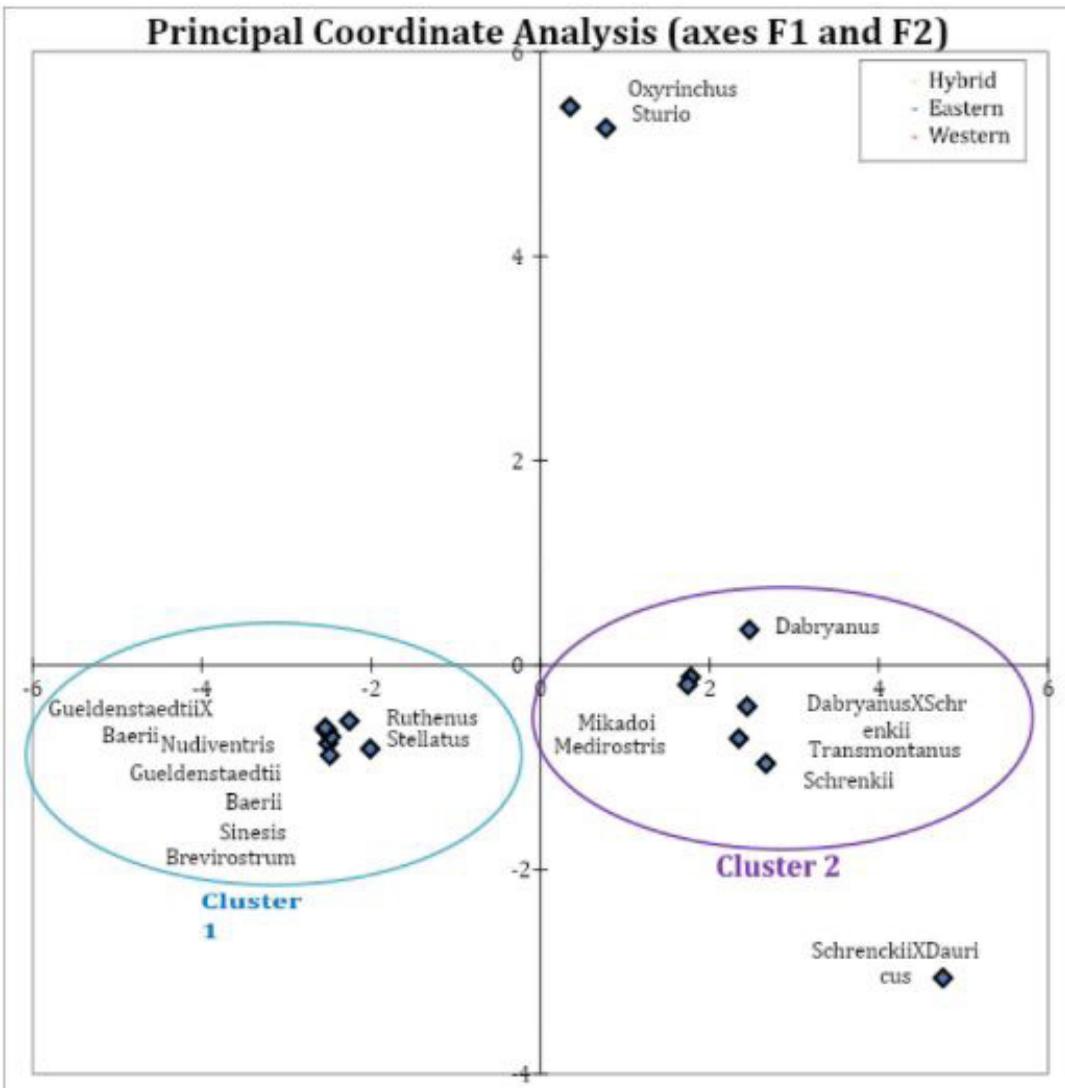


Figure 1: PCoA of all *Acipenser* species comparisons. The y and x axis show the distance of dissimilarity between species. Closer clustering represents little dissimilarity (or higher similarity), while long distances between species mean they have high dissimilarity (or little similarity). Note that blue species are Eastern, red are Western, and orange is the hybrid cross of *Huso dauricus* and *Acipenser schrenckii* which are also part of the *Acipenser* genus.

Coast. There is a noticeable difference of observed crossovers between species along the Atlantic and Pacific Coasts. It would be worth researching reasons why species along the Atlantic Coast are less prone to cross over than species along the Pacific Coast, to preserve endangered Acipenser sturgeons more efficiently.

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# RACIAL OPPRESSION ADAPTATIONS IN EDUCATION

Jakob Johnson

*ABSTRACT: In post civil-rights America, popular opinion is that racial oppression has either completely disappeared or is insignificant compared to a hundred years ago. But how accurate is this assumption? Sensoy and DiAngelo's *Is Everyone Really Equal* explores the fascinating phenomenon of how oppression can change its appearance to blend in with the times (Sensoy & DiAngelo, 2017, ch. 7). This essay explores how oppression has made itself degrees more invisible to the everyday person, highlighting specific examples in the educational system. In our attempts to be antiracist, we have fallen into several pitfalls that inevitably do more harm than good. Businesses, in order to appear antiracist, market their antiracism rather than practice it. We have implemented items in the classroom that seem progressive while actually doing nothing to inform about systems of unequal power. By focusing on individual acts of racial oppression and antiracism, we obscure overall patterns of racial oppression and maintain the system at an invisible level. These new and modern forms of oppression demonstrate that older forms have been transformed and concealed rather than eradicated.*

With the groundbreaking case of *Brown v. Board of Education*, the Supreme Court found racial segregation in the school system unconstitutional as of 17 May 1954. Today, schools around the United States celebrate Black History Month, teach Black literature, and honor Black leaders. It seems like equal access to education has progressed by leaps and bounds compared to what it was. No doubt, that is the great success story we are taught in class: with the revolutionary work of Dr. King, all racial oppression has been eradicated. Eradicated—except for those lone instances of violence. But those, we are taught, are committed by the small-minded and the hateful; *they* are the exception, *they* are the racists, and *we are not*. That is what I was taught. However, oppression is not single acts of aggression, nor can it be redressed by single (though grand) acts of justice. Oppression is systemic, eclectic, and most importantly, slippery, with a tendency to adapt to new social climates (Sensoy & DiAngelo, 2017, ch. 7). It involves “institutional control, ideological domination, and the imposition of the dominant group’s culture on the minoritized group” (Sensoy & DiAngelo, 2017, ch. 5). Therefore

it does have acts of violence, white-washed history, unequal opportunities for success, and so forth, but none of these are entirely oppression. Oppression is all these items stacked together: synergy in its worst iteration. Now, in a time when outright and obvious oppression (for the case of this paper, racial oppression specifically) is no longer acceptable, oppression has hidden itself, making it more difficult than ever for most of us to detect and nearly impossible to eliminate. Specifically in the education system, this invisibility is extremely dangerous and is one of the strongest forces maintaining itself.

The history of education in the US is tied with elitism and classism, in which racial exclusion has had no small part. We all think of the racial segregation of schools as the first and foremost example, but that is just one ramification that *Plessy v. Ferguson* (1896) had (or expanded) on Black education. Post *Plessy v. Ferguson*, white persons had legal justification for treating Black persons as second-class citizens. The schools were segregated by race, Black schools were few and far between, and there was limited transportation for Black students at that time,

making Black education inaccessible as well as sparse (*Roberts v. Boston*, 1850). Not only that, but in many places it was against the law for white educators to teach Black students, citing the Virginia Criminal Code of 1847. An article by T. Elon Dancy, the associate dean of equality and justice at the University of Pittsburg's School of Education, Kirsten T. Edwards, a professor of educational leadership and policy at the University of Oklahoma, and James Earl Davis, a professor of policy, organizational, and leadership studies at Temple University, explores white privilege in the university setting during colonial times, remarking on routine instances of rape, verbal degradation, and inhumane abuse from the students to the slaves working on the grounds (2018, p.9). Even after *Brown v. Board of Education*, Dancy cites incidents of targeted sabotage on Black education: "The continued defunding of historically Black colleges and universities (HBCUs) reflects a sordid commitment to the elimination of Black enterprise. It also undergirds the relationship of trauma between Blackness and the educational system; a relationship HBCUs play a protective role in fighting against" (Dancy, Edwards, Davis, 2018, p.17). Overt race-motivated oppression like this has not completely disappeared. There are still an unfortunate number of acts of outright violence and hate, although comparatively fewer. We like to think that we have improved and that racial oppression is diminishing, but I argue that the apparent decrease we have made is not us defeating oppression but is merely transmuting it into newer less-obvious forms.

The first form that oppression has transformed itself into is a corruption of antiracist education. At its core, antiracist education is giving equal opportunity to students of all ethnicities, creeds, and identities. It is not, as many think, the process of installing a minority as a new dominant group while oppressing the predecessor (Sensoy & DiAngelo, 2017, ch. 9). Thinking as educators, there are many methods to bring antiracism into the classroom. Jane Elliott, a teacher from Randall Iowa, came up with an interactive

lesson where she, and the brown-eyed students she encouraged, actively discriminated against those with blue eyes. Then the next day switched who gets discriminated against, demonstrating the arbitrariness of discrimination (OWN, 2020). There are less dramatic methods which convey the same point, such as teaching a more accurate, if unpleasant, US history instead of the current jingoistic rose-tinted curriculum. Alternatively, one can introduce gentler (relative to Jane Elliott's) diversity activities, or simply celebrate media and art from a variety of voices and ethnicities. However, critically, not failing to include the unequal power systems that are intertwined with those pieces, since that is the core of their antiracist message.

Antiracist education is hard to do but not impossible. The uncomfortable truth is our schools and institutions are not making curriculum choices solely as educators, but they are also making them as marketers. Procuring a full student body (as well as sponsors and good reputation) is imperative to the livelihood of our educational staff members and the success of their schools. Antiracist education is ideologically complex and therefore not easily or economically pushed on the body of consumers: parents, prospective students, reviewers, and so on. It is very difficult to advertise an abstract idea, and more so to sell something you cannot immediately see. The question changes from how our antiracist education could be most effective to how our antiracist education could be most commercial. More insidious cases even purposefully avoid real antiracism and go entirely for the appearance of antiracism while actively appealing to racists. All these cases mingle economic principles with (or more accurately, against) antiracism, diluting its effectiveness and changing it from an instructional form of education to a sellable one. Thus, the educator's dilemma.

How does this manifest in the classroom? A simple and immediate result is what we call "celebrations of diversity." There is nothing

intrinsically wrong with this; it is a vital facet of living in a multicultural society for its groups to celebrate their differences and heritages. The issue is that these celebrations fail to take into consideration the history of power imbalances these groups have faced and continue to face. In my elementary school it was a tradition for the classes to light a menorah during Hanukkah, but I never knew about the centuries of oppression the Jewish people had faced. That was never part of the curriculum; I just thought it was a fun and festive thing to do. There was no critical thinking, no conceptualizing of what I was doing or its significance. As Sensoy and DiAngelo put it:

In practice, this approach to multicultural education is the ideology of individualism applied to each unique ethnic group in a school. Celebrating diversity is important, but because it tends to occur without a study of power, this celebration actually reinforces structural inequality by obscuring unequal power between groups (2017, ch. 9).

I like to think of it as a feel-good tactic. It's a tangible, simple, fun, and obvious thing we can do as well as a juicy bullet point to advertise on, but in terms of antiracism, it just obscures the point. It is irrelevant at best. This feel-good practice manifests itself in several other forms as well. There's the fascinating phenomenon of tokenism: planting Black persons in obvious positions gives the appearance of progress, or most devious, the philosophy of colorblindness: "Seizing on one part of King's speech—that one day he might be judged by the content of his character and not the color of his skin—dominant culture began promoting the idea of 'colorblindness' as a remedy for racism" (Sensoy and DiAngelo, 2017, ch.8). This one's layered: it's an equality-based philosophy for human interactions (congruent with antiracism), and impressively based on one of the most famous speeches delivered on the subject of race inequality in America. What is the problem? Exciting progressive motives aside,

this is a do-nothing philosophy. Pretending that racial oppression does not exist is exactly what is keeping it running. And worst of all, it is nearly impossible to say that it is problematic. If brought up, the accused would defensively say, "But how can we be oppressors? How can we, when here we are celebrating minority holidays!" How can they? What is inherently oppressing about such simple celebrations? This brings me to my next point, viewing oppression in pieces.

Viewing racial oppression in terms of single acts, both good and bad, is one of the most detrimental and counterintuitive systems to antiracism. But like every form of hidden oppression, it is paved with good intentions. As stated, the actual antiracist rhetoric is not flashy nor intrinsically motivating. How do we understand, let alone resolve, a system of control over minoritized groups that is in everything from commercials to textbooks? Where do we start? We make goals, attainable simple goals; open this, remove that. And when we rally our friends behind our cause, we say, "Look at this atrocity! *Her* baby killed! *This* man hanged! *That* woman's son in a cage!" If we subdivide antiracism into little bites, it makes progress seem a lot faster. But as this continues for some time, and we zoom out a little, we see our understanding of racial oppression begins to be colored by these examples and goals. Racial oppression, in a way, becomes these individual atrocities we read about and watch. Likewise, our image of the racist has become the nasty creatures who commit these heinous acts, distancing the majority of the dominant group from the nuance of oppression. You and I have not painted swastikas on Jewish gravesites, therefore we cannot be racists. At the same time, we pass X Reform or hold Y Rally to meet whatever ends we are aiming for, and think that because we have met Z, therefore racial oppression has ended (or is so much closer to ending)! This makes us think that it would undermine the effect of all our accomplishments to say that racial oppression is still extant (another

justification for colorblindness and similar do-nothing philosophies). Many of us are almost scared to admit the problem is still as big as it is, even after so much work. In the words of Sensoy and DiAngelo, “The way that dominant culture focuses on individuals obscures grouplevel patterns” (ch. 7). The ‘grouplevel patterns’ are the enforced ideologies, control of institutions, and subtle socialization of the dominant culture’s authority over the marginalized groups that drive and perpetuate oppression. Focusing on single acts de-synergizes oppression into individual cruelties. By coloring the image of the racist oppressor as a deranged sadist (the same image I have in my head), it has influenced us to defensively deny any implications of racial oppression. This is detrimental because if we refuse to accept that we participate in the oppressive system, we cannot work to continue dismantling it. Likewise, if we continue to think that racial oppression is ended, we are allowing racial oppression to continue unchecked and uninhibited in the background, beyond our personal awareness.

How does this operate on the level of the school? Dancy, Edwards, and Davis looked at how higher education handles incidences of racially motivated violence: “Higher education’s insistence on characterizing anti-Black violence as incidental or anomalous functionally erases the history of trauma experienced by Black bodies on white campuses” (2018, p.18). This is the same issue as celebrations of diversity: the incident is taken out of context and treated, as the authors stated, anomalously. But the whole point is that it isn’t an anomaly—this is the progression of centuries of oppression. By excusing it as an anomaly, the subtext is that it shouldn’t happen again, but by failing to resolve the systems and the socialization that lead to the act in the first place, we are ensuring that it will happen again. The same article continues, saying, “[Institutions] frame white perpetrators as foolish and ignorant, possibly even racists, but not as terrorists enacting violence against Black life. In addition, the modus operandi prioritizes

the public image of the white institution, not the assault on Black humanity” (Dancy, Edwards, Davis, 2018, p.18). Again, as with someone being called a racist, or the widespread use of feel-good tactics, it is not about the action nearly as much as about one’s image. Condemning racist acts at school works very well at making the institution seem progressive and antiracist while failing to correct anything. It’s very difficult to say to these schools trying hard to be inclusive that they are *still* part of the problem after so much sacrifice and fighting for equality. How ungrateful of us it must seem to them, despite everything they’ve done. However there is always a way to resolve things.

I have explored two broad categories of modern oppressive practices: obsession with self-image and viewing instances of racial oppression as individual acts. But perhaps the broadest reason why oppression is still so deeply rooted in today’s society is because we are approaching a mutating problem with a static education. There should never be a single curriculum on racial oppression. What we taught students ten years ago about oppression is out-of-date today. Plenty of data show that proper education is the key, but our education has to be just as dynamic as the racial oppression it fights. Simply defining oppression and learning about it does not meet the current need because learning about racial oppression rather than experiencing it from birth is a high privilege of the dominant culture. Perhaps it is better to follow the Jane Elliott model and experience it for ourselves, even in a classroom simulation. As controversial as it is, perhaps the radical and shocking approach is necessary to deliver a message strong enough for the individual and relevant enough to match the times. Of course, such a curriculum can only be provided if institutions behave as institutions and not as businesses. Distilling economics and politics out of our schools is a very relevant and parallel conversation to the one we are having. But again, I cannot emphasize enough the detriment of rigidity. Rigidity in our thinking leads to our defensive responses. Like our

education, we should have the tools to regard ourselves as dynamic beings learning to combat oppression, always willing to listen to criticism, and always looking for instances where we might be limiting somebody else. When we say, “I don’t need to change,” we are participating in the evolution of new oppression.

Postscript:

This essay was written before the 2020 election and its aftermath. It is disheartening to see the degree to which overt white power seems to have become visible and acceptable again.

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# USING COMPUTER PROGRAMMING TO SEARCH FOR TRENDS IN THE ATMOSPHERIC COMPOSITIONS OF EXTRASOLAR PLANETS

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*ABSTRACT: Since the discovery of extrasolar planets (planets orbiting another star) in the early 1990's, more than 4,350 exoplanets have been confirmed to exist as of February 2021 according to the NASA Exoplanet Archive. Given the large amount of new data generated on exoplanets, our research team has been searching for trends between exoplanets' atmospheric compositions and their physical and orbital properties. We have developed computer programs to automate the steps in our process of searching for these trends. These steps include gathering exoplanets' physical and orbital property measurements, identifying planets within our search scope, studying the atmospheric composition of exoplanets, and searching for potential trends. In addition to developing programs, we place a heavy emphasis on the documentation of our programs and processes. By providing extensive documentation, we strive to make our programs and processes easily understandable and usable for the astrophysics research community. Our team aims for our results, programs, and documented research processes to be published on forums such as GitHub, together with research journals.*

## 1. Introduction

In 2001, the first detection of sodium absorption in an exoplanet's atmosphere was made (Charbonneau et al., 2002). Since then, a growing number of more than 4,100 exoplanets have been confirmed to have published atmospheric data (NASA Exoplanet Archive). Transmission spectroscopy is used to determine the existence of an element or molecule in a planet's atmosphere. If an exoplanet contains an element/molecule in its atmosphere, the light from its host star passing through its atmosphere at a wavelength corresponding to the element/molecule will be absorbed.

In addition, there has been a large amount of physical and orbital data collected and published on websites such as the NASA Exoplanet Data Explorer. However, few studies have been conducted with the purpose of determining trends between physical/orbital data and atmospheric data. Our research is focused on finding these trends.

With the increase of data on exoplanets needed to analyze in our search for trends, we needed to develop a system to automate the extraction, organization, and analysis of data. Our research process has time intensive and data heavy tasks that allow for human error. The ability for computer programs to process large amounts of data and automate processes will help us to reach accurate conclusions efficiently.

## 2. Methods

Our goal with our computer programming is to automate the search for trends between the physical/orbital properties and the atmospheric composition of exoplanets. In Section 2.1, we show the automatic method we have developed to collect data on planets within a specific scope. In Section 2.2, we explain our program that follows the requirements of a criteria to automatically conclude whether a planet has atmospheric absorption of an element or molecule. In Section 2.3, we describe how our plot-making programs help us to search for trends. Section 2.4 explains the database we are developing to

store and manage the most recent data needed for and generated by our research. Lastly, in Section 2.5, we explain the documentation for our computer programs, which help make our programs accessible and easy to understand.

### 2. 1 Planet Selector Program

Our primary source of data on exoplanets’ physical and orbital property measurements is the Habitable Zone Gallery (Kane et al., 2012). This website, developed by Dr. Stephen Kane and Dr. Dawn Gelino, extracts the names and measurements of physical and orbital properties of exoplanets from the NASA Exoplanet Data Explorer and calculates, among other things, the extent of the habitable zone around each exoplanet’s star and the percentage of time the exoplanet spends there during its orbit. The website lists this information in a table, which can be downloaded in the form of a

.csv (comma-separated value) file. To collect our data, our team downloads this .csv file and uses a computer program to find which planets fall into our search scope. The search scope is an area of focus consisting of a range of two physical or orbital properties.

Our team developed a Python computer program, named the Planet Selector Program, to read the .csv file and create a Microsoft Excel Sheet that lists the names of the planets within our search scope along with their physical and orbital property measurements given in the Habitable Zone Gallery (Maloney et al., 2017; Weber et al., 2019; Broussard et al., 2020). In addition, this program creates a scatter plot that plots all planets included in the HZG table based on any two physical properties and draws a red box indicating the search scope of our current search. Figure 1 is the scatter plot created by the Planet Selector Program to represent our

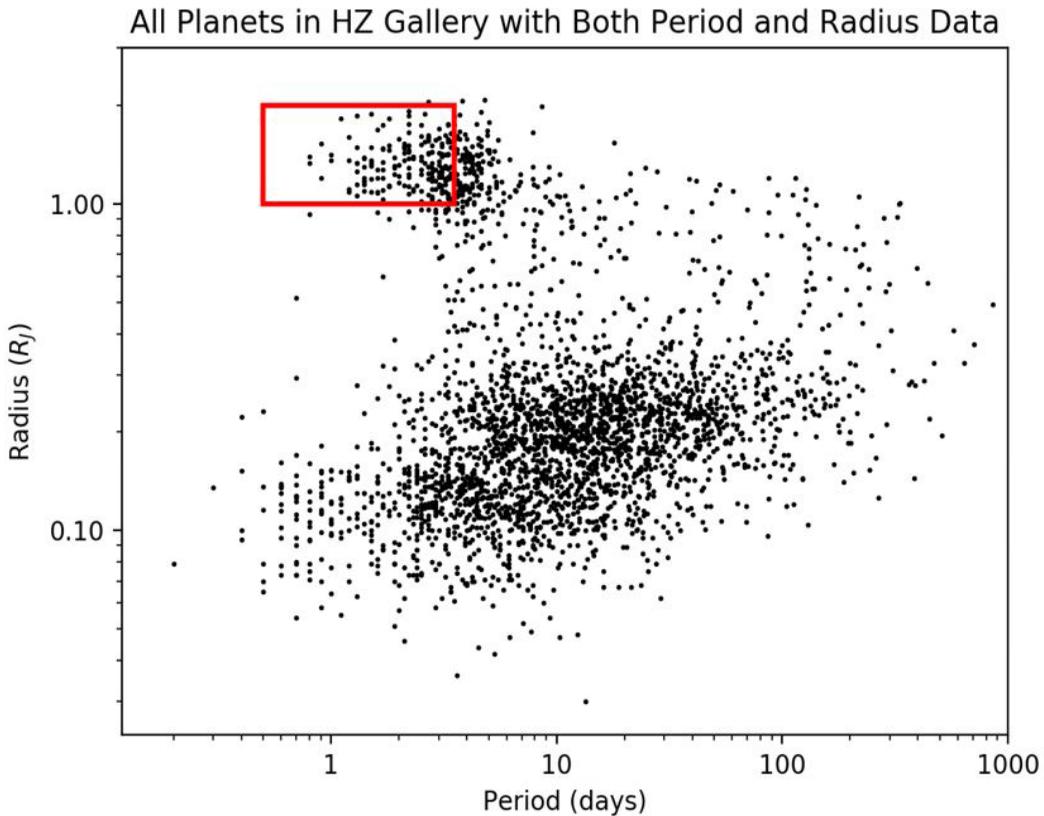


Figure 1 (above): Plot of all the planets in the Habitable Zone Gallery based on orbital period and radius measurements with a red box indicating the search scope.

current search scope of exoplanets with orbital periods of less than 3.5 Earth days and radii between 1 and 3 times the radius of Jupiter. We have developed a functionality within the Planet Selector Program that allows the user to input the two physical properties they would like planets to be graphed based on and the ranges of these physical properties they would like to represent as the search scope. After inputting these values in the indicated section of the program and running it, both the scatter plot and the Excel Sheet are saved to the files specified in the user inputs section of the program.

To keep up with the fast pace of exoplanet and exoplanet property findings that is a result of the improvement of detection technology, we are currently modifying the Planet Selector Program to directly read from the Habitable Zone Gallery website. This will ensure that we are working with the most recent data and eliminate the need to download the .csv table. We are in the process of creating a series of programs to make scheduled data extractions

from the website. These data extractions will automatically occur every few days and update the data and scatter plot generated by the Planet Selector Program if there are any changes to the data in the Habitable Zone Gallery since the last extraction.

## 2. 2 Planet Absorption Criteria Program

After using the Planet Selector program to find which exoplanets are within our selected search scope, the next step in our search for trends is concluding the exoplanets' atmospheric absorption characteristics.

After reading through published literature on exoplanets in our search scope to find atmospheric absorption data, we note which wavelength ranges overlap. We choose a wavelength range that contains absorption of one or more elements to focus on. We then collect data on published literature on planets with spectral data in the chosen wavelength range, specifically looking for conclusions that the authors of the paper make on whether a

### Exoplanet Element Absorption Criterion

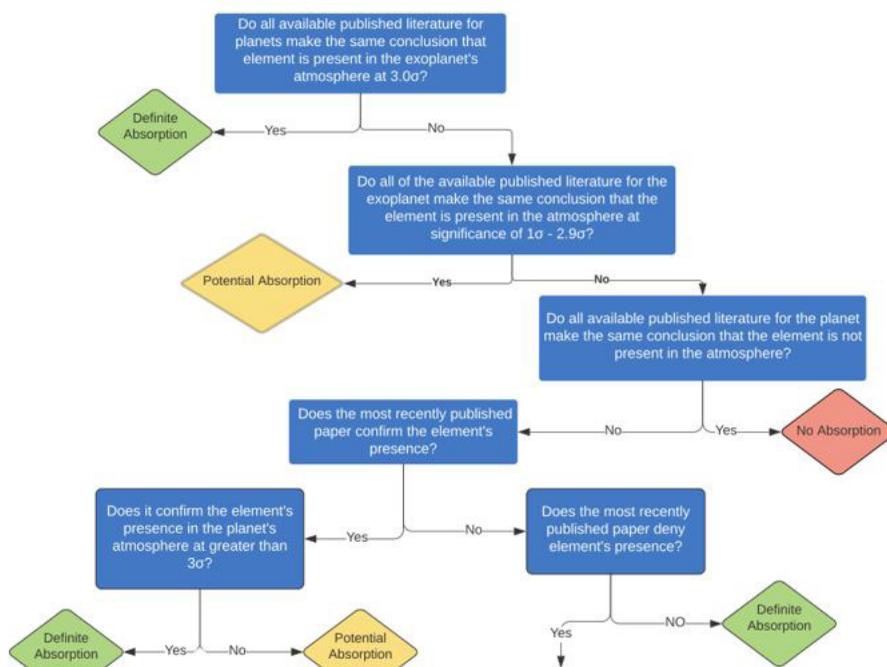


Figure 2 (above): Section of the Criteria flow for determining sodium and potassium absorption in an exoplanet's atmosphere.

planet has atmospheric absorption of an element or molecule.

Oftentimes, multiple papers written on a single planet make contradictory conclusions. This can be caused by the instruments used, the time the data was collected, or variability in the presence of haze/clouds in the atmosphere of the exoplanets. We have developed several criteria to classify whether a planet has atmospheric absorption of sodium, potassium, or water when contradicting conclusions are made between different papers. The criteria take into account the conclusion authors from each paper make on a planet's absorption of sodium, potassium, or water; the number of papers with authors that make a specific conclusion, the dates that the papers were written, and the instruments used to make these detections. The criteria we developed are designed to consider each piece of information listed above in a specific order of requirements. After following the instructions of the criteria, a planet can be concluded to have definite, potential, or no absorption of sodium, potassium, or water. Figure 2 shows a section from the criteria we developed to determine an exoplanet's atmospheric absorption of sodium and potassium.

Currently, members need to go through the criteria manually. This is a very time-intensive and detailed process, which can easily lead to human error. To solve this issue, we decided to develop a program that follows the requirements of this criteria and outputs the classification of absorption each planet has of sodium, potassium, and water. The Planet Absorption Criteria Program reads data needed for the criteria directly from a Google Sheet in the research team's shared Google Drive. To achieve this functionality, the Python API for Google Sheets, "gsread" is imported into the program. This allows the program to open, read, and write to the specified Google Sheet. To direct the program on which Google Sheet to write to, a JSON file that corresponds to the Google Sheet is saved to the same folder in

which the program is saved to. The file is used in the program to verify that the person running the program has the credentials to open, read and write to the Google Sheet. Researchers will not be able to direct their program to access the Google Sheet if they do not have access to the JSON file.

By implementing a connection between a Google Sheet and the Planet Absorption Criteria Program, any updates made to the data happens in one place only and the program reads the most recent data.

## 2. 3 Property Plot Program

Our next step is to determine if there are correlations between the physical/orbital data and the atmospheric data. To do so, we create scatter plots that graph planets based on two physical or orbital properties and indicate each planet's absorption characteristics (Broussard et al., 2020). As it can be seen in Figure 3, one physical or orbital property is used to represent the x-axis, and another physical or orbital property is used to represent the y-axis. The colored points are used to represent planets. The green circles around the points represent potassium absorption in the atmosphere of the planet represented by that particular point. The blue circles around the points represent sodium absorption in the atmosphere of the planet represented by that particular point. Solid green and blue circles around points represent definite absorption of these elements. Dashed green and blue circles around points represent potential absorption of these elements. No green and/or blue circles around a point represent no absorption of these elements.

We are in the process of solidifying a set for criteria for water and have not yet classified planets based on their water absorption. Therefore, Figure 3 does not include water absorption.

We use these scatter plots created by the Property Plot Program to look for trends by

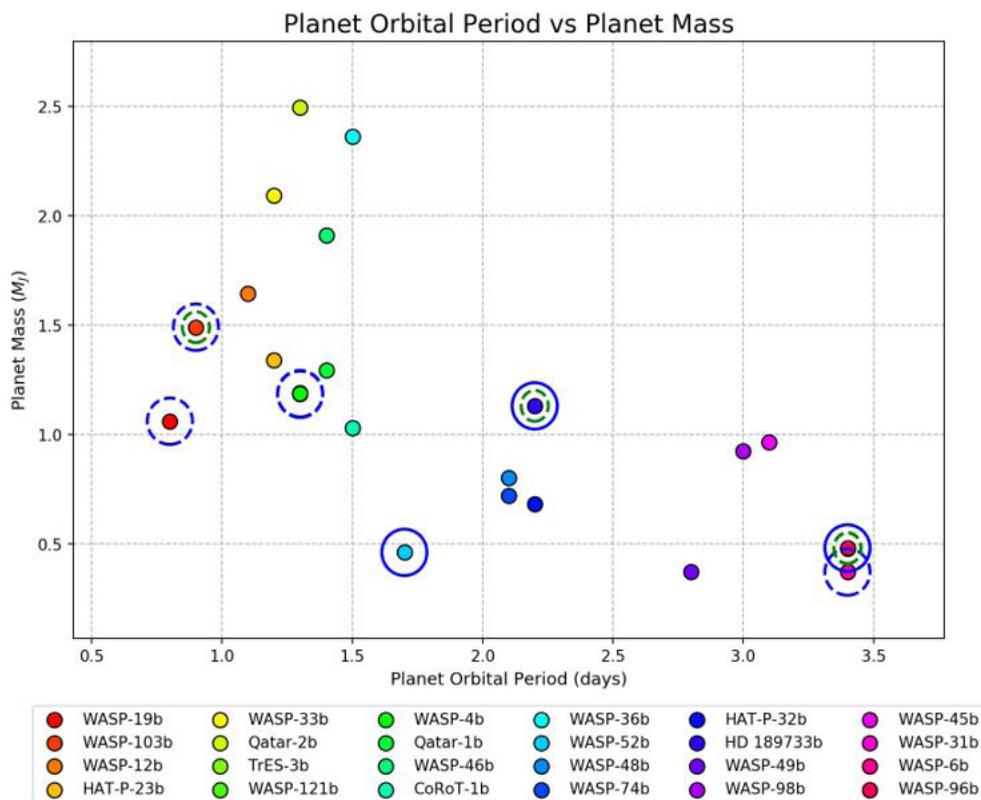


Figure 3 (above): Plot of planets based on orbital period and planet mass with sodium absorption indicated by blue circles around points and potassium absorption indicated by green circles around points. Dashed circles around points correspond to potential absorption and solid circles around points correspond to definite absorption.

noting whether all or most points with blue and/or green circles around them show to be in one specific section of the plot. For example, if most of the points with green circles around them fall in the section of a plot that indicates a relatively large mass and small radii, we can conclude that exoplanets with potassium absorption in their atmospheres have large masses and small radii. These scatter plots provide a way to bring our physical/orbital data and our atmospheric data together and see the correlation between the two. Statistical analysis, specifically 1D and 2D ks-testing, is conducted beyond this point to confirm the trends concluded.

## 2.4 Database

We are currently in the process of creating a PostgreSQL database to hold all of the collected data. Interfaces that increase accessibility will be implemented so team members with various

research backgrounds can easily access and use the data. Implementing the database will require us to switch from using Google Sheets as our shared data forum to a SQL database. The switch to the database would enable our team to easily access the same, most recent data in one place. However, this affects all of our software and we will need to modify each of the programs to use the database to input and extract our data. More specifically, this means the location(s) of the inputs and outputs of our programs will be changed to the SQL database.

## 2.5 Documentation

All our published programs will be documented using Sphinx. Sphinx is a documentation tool that can be used for various software languages. The documentation would make our programs and processes more understandable to researchers that are not as

acquainted with our research. As a future goal, we would like to publish our work and software to GitHub and other public platforms for others to use, and our documentation would allow them to do so with ease.

### 3. Conclusion

Computer programs have shown to improve our search for trends by automating our steps and returning accurate data and results. With them, we have been able to establish a search scope and collect data on exoplanets within that scope efficiently, automate the process of determining whether a planet has absorption of an element or molecule, and make conclusions on trends between the atmospheric composition and physical/orbital properties of exoplanets. The addition of our database ensures the most recent data exists in a localized platform that is easy to access and is reliable. Finally, our computer program documentation will help our team members and other researchers efficiently learn how to use our programs.

By integrating computer programming as a vital component of our research, we show how astrophysics and computer programming go hand-in-hand, better acquaint members of the research group with programming, and provide the astrophysics research community with highly versatile and applicable programs to be used for different types of research on exoplanets.

All members of our research team are required to learn basic programming in order to develop, run, and understand what our computer programs do. By guiding them through this process, we are educating research members on skills that are relevant in several STEM fields. Our team aims for our programs and documented research processes to be published on public forums such as GitHub, as well as research journals. The results of our search for trends in the atmospheric compositions of extrasolar planets will be included in the Habitable Zone Gallery. This way, our programs, processes, and

results will be accessible to the community of researchers who wish to use this information as well.

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# DIET COMPOSITION AND SPECIES RICHNESS IN THE GUT MICROBIOME

Jacqueline Monteza, YeJi Oh, Erin Nicholson, & Mehran Serai

*ABSTRACT: The gut microbiome plays a very important role in the health of human beings by helping to control digestion and benefiting the immune system. Furthermore, the role of the human gut microbiome stretches its involvement in human metabolism, nutrition, and physiology. The role of diet in the human gut microbiome, in particular, has been linked to regulating the risk of several chronic diseases like obesity, type 2 diabetes, cardiovascular disease, and cancer. Researchers now know that diet plays a significant role in shaping the gut microbiome, with studies showing that dietary alterations can induce large, temporary microbial shifts within a short period of time. Monitoring how a change in diet can affect the overall diversity and stability of the human gut microbiome can help researchers understand the extent of microbiota plasticity. The purpose of this paper is to examine the microbiota richness in the human gut microbiome present in a plant-based diet versus a meat-based diet. In order to compare the results of the existing literature on diet and microbiome change, we conducted a meta-analysis of four studies using raw meta-data from the QIITA database, an open-source microbial study platform.*

*The data from studies previously conducted were extracted from the QIITA database and were analyzed by running alpha diversity significance and beta diversity significance tests in the QIIME2 server, a software for microbiology analysis. The results for the study that evaluated the microbiome richness and the total number of microbiomes in the gut in a high-fat versus a low-fat group showed that there was a statistically significant difference among the diets with clustering shown in the data. The analysis of a study that examined changes in the microbiome of the gut induced by the consumption of a meat-based versus a plant-based diet indicated a statistically significant decrease in species richness in those that consumed a meat-based diet. The results for the study that evaluated the microbiome richness in a high meat versus a high polysaccharide diet showed that there was a statistically significant difference among the diets, with clustering and dispersion shown in the data. Conversely, a study that evaluated the microbiomes of young children that ate a high versus low number of daily servings of animal protein showed insignificant differences between the two groups due to confounding variables. These findings can further contribute to existing data on how a change in diet can affect the types and abundance of microbiota present in the human gut microbiome.*

## Introduction

The human body has been the subject of intensive study by scientists all around the world. While a lot of discoveries regarding its anatomy and physiology have taken place, there are many components of the organism that continue to be experimentally investigated. One heavily studied aspect of the human body is the microbial community of the gut, and how its stability and species diversity are

impacted by various factors. There are many different factors that can induce changes in the bacterial communities of the gut, one of them being the composition and diversity of diet consumed by humans. Because the dense microbiome ecosystem found in the human gut is fundamental in maintaining healthy physiological function (Osman et al. 2018), disruptions in the stability of the microbial communities induced by stressors such as a change in diet composition may be correlated

with a predisposition of developing disease, although this aspect remains the topic of much research. Furthermore, microbiomes often show plasticity in response to diet, meaning that changes in diet can alter the composition of microbial communities and thus have the potential to shape the overall function of the community (Harris et al. 2019).

The impact of diet on the bacterial species that are in the gut can be exhibited in short-term experimental scenarios, such as studies that alter subjects' diets and then assess microbial shifts in feces the following day. There are also studies which indicate that changes in diet can induce large, yet temporary shifts in the microbiota of the gut within 24 hours (Singh et al. 2017). When tested in long-term scenarios, an examination of how the stressor of diet composition affects the microbiome stability can be useful in regulating the risk of various chronic illnesses, such as inflammatory bowel disease, obesity, type 2 diabetes, cardiovascular disease, and cancer (Singh et al. 2017). Therefore, there are various applications for analyzing the effects of a stressor on the human microbiome. One of the goals for this kind of research is to expand beyond a simple description of microbial species and genes that are present in a particular habitat and connect the composition and the functions of microbial communities to human biology and pathobiology (Turnbaugh et al. 2009). There are various ways to quantify bacterial species composition in response to a stressor, but common DNA-based methods in current use rely on identifying 16S rRNA, a gene that encodes for the 30S small subunit of the ribosome which is easy to amplify due to conserved regions, and is specific to each bacterial species due to regions of the gene that are highly variable (Sweeney and Morton 2015). The reason this specific gene is sequenced is because the 16S rRNA gene is an exclusive gene in prokaryotic organisms that can be used to determine microbial species within samples of the microbiome (Osman et al. 2018). The effect of diet composition can be studied in human gut

microbiomes across all age groups, and many studies use fecal samples from adult humans to examine any changes in the gut microbiome. In this study, we seek to examine how a meat-based diet versus a plant-based diet affects the richness of microbial communities in the guts of adult humans. We will do this by conducting a meta-analysis of four different existing studies that explored changes in microbial richness in response to plant- and meat-based diets. We expect that a meat-based diet will decrease microbiome richness because it will have a smaller range of species diversity than a plant-based diet.

## Methods

To analyze the effects of diet composition in the richness of microbial communities in the human gut, we first gathered multiple studies from the QIITA database. QIITA is an open-source platform used for microbial study and houses raw 16S rRNA gene sequencing meta-data collected by other researchers. Each member in our research group downloaded all mapping and BIOM files of one study from the QIITA database and uploaded them to the input file in QIIME using the CyberDuck application. We then proceeded to unzip the raw 16S rRNA meta-data from the procedure folder using specific computational commands, which can be found in the supplementary data section of this paper. This created 3 folders in QIIME: BIOM, mapping\_files, and processed\_data. To simplify our analysis, we copied the sequence and feature table data from what is the most recent version and put it into the top-level input directory. The next step was to import the BIOMfile and all.seqs.fa into a QIIME 2 FeatureTable[Frequency].qza file and QIIME respectively.

Before running alpha and beta diversity analyses, we rarified the feature table to an even number of reads because if one sample has 1,000 reads while another has 100,000 reads, it could affect how similar they appear even if

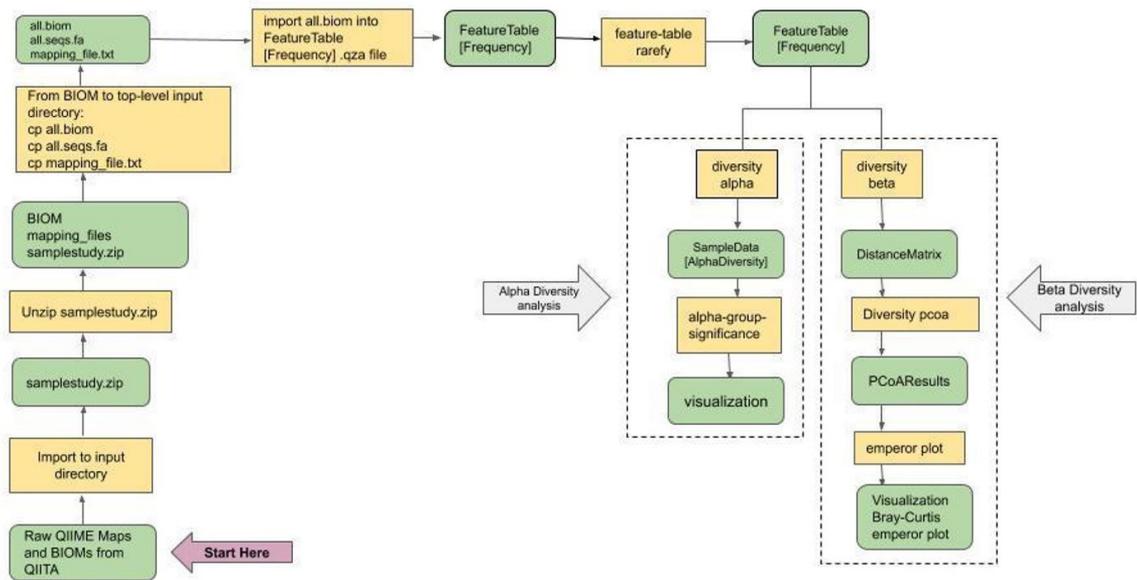


Figure 1. Workflow diagram of methods used for data analysis.

biologically they are the same. To test for beta diversity of our samples, we ran two statistical analysis tests, PERMANOVA and PERMDISP, using the `bray_curtis_distance_martrix.qza` parameter. The PERMANOVA statistical analysis test would tell us if we either have a clustering or dispersion effect by giving us a significant p-value, whereas PERMDISP would give us a significant p-value for dispersion. Next, we ran a test for alpha diversity using the `observed_features_vector` parameter. Finally, we combined the results of the beta and alpha group significance test to analyze our data.

## Literature Review

Previous research has examined the impact of various diets on the balance and composition of the gut microbiome, ranging from strictly vegan diets to entirely carnivorous diets. For the purposes of our research, we focused on investigating a plant-based diet and a meat-based diet, where a plant-based diet consists of no animal product consumption and can best be described as a vegetarian diet, in which nutrients

are mainly derived from fruits, vegetables, grains, and legumes (David et al. 2013). A meat-based diet is that in which nutrients are largely derived from animal products and is relatively higher in fat than a plant-based diet (David et al. 2013). Studies have indicated that consumption of a plant-based diet has been associated with an increase in the stability of the gut microbiome, as a higher abundance of microbial species responsible for cell mobility, hydrolyzing enzymes, transport systems, and the synthesis of vital amino acids and vitamins has been observed (De Angelis et al. 2020). In contrast, consumption of a meat-based diet is seen to be correlated with a decrease in the beta diversity of microbial species of the gut, while little difference in alpha diversity between subjects that consumed either a plant-based diet or a meat-based diet has been observed (David et al. 2013). Recall that alpha ( $\alpha$ ) diversity can be described as the quantification of microbial species diversity and abundance in the gut at the point in time when samples were analyzed, and beta ( $\beta$ ) diversity is a measure of the difference

between the baseline microbial composition of the gut and microbial composition of the gut after exposure to the diet being studied (David et al. 2013). In previously published literature that we examined as part of this research project as well as in our data analysis, it was observed that similar phylogenetic groups of microbiotas tend to cluster together in graphical analysis plots of beta diversity like the Bray-Curtis emperor plot, the statistical significance of which is measured by the PERMDISP and PERMANOVA statistical tests. For example, in a study conducted by David et al. in 2013, the analysis of 16S rRNA gene sequencing data indicated that the consumption of a meat-based diet had a larger impact on the composition of the gut microbiome than a plant-based diet, as 22 clusters of microbial species showed a significant change in abundance. However, when participants were exposed to a plant-based diet, only 3 clusters showed statistically significant change in abundance.

We did our own analysis of raw 16S rRNA metadata collected from subjects in four different studies where participants consumed either a predominantly plant-based or meat-based diet, the original results of which we will now describe. The first study we analyzed was conducted by Wu et al. in 2011, and his research group observed the relationship between different diets and their impact on gut microbiota. Specifically, his research team explored how high fat (meat-based) and low fat (plant-based) diet groups changed the composition of gut microbiota. They found that over the 10 days in which they exposed 10 subjects to either diet group (low fat/plant-based or high fat/meat based), changes in enterotypes were significant and rapid. However, the changes were not sufficient enough to categorize individuals into enterotype clusters. They also found that dietary associations to gut microbiomes paralleled a European study that tested diet with high protein and fat versus high carbohydrate and low-fat diet (Wu et al. 2011). The second study we analyzed was originally conducted by David et al. in 2014,

and his research team investigated the effects of a meat-based diet versus a plant-based diet on the composition of the gut microbiome. As described previously in this section, the results of this study indicated that consumption of an animal-based diet was correlated with an increase in beta-diversity in the gut, as the abundance of 22 clusters of bacterial species significantly changed (David et al. 2011). It was observed that adherence to a plant-based diet resulted in only 3 clusters of bacterial species showing changes in abundance over the experimental period (David et al. 2011). They also found that clusters of bacteria seen most prominently in the gut after consumption of an animal-based diet were resistant to bile, which is consistent with the observation that a high fat intake (seen in a meat-based diet) causes higher levels of bile to be secreted (David et al. 2011). A third study by Ruggles et al. focused on examining the human gut microbiome richness between a high meat-based diet (associated with an urban environment) versus a high polysaccharide-based (a plant-based diet associated with a traditional rainforest environment) diet in adults and children. They observed that beta diversity and alpha diversity decreased in individuals that consumed a plant-based diet, while alpha diversity increased in children consuming the same diet (Ruggles et al. 2018). Their overall results indicated that there is greater stability in the adult microbiota, with less resilient bacterial species in children's microbiota that changed most prominently in response to dietary changes made during the experimental period (Ruggles et al. 2018). The last study we analyzed was conducted by Smith-Brown et al. and explored changes in the gut microbiome of children between the ages of 2 and 3 that consumed either a high or low number of daily servings of animal proteins, with a median of 1.88 servings. Their results indicated that consumption of animal protein was associated with a decrease in species richness and diversity in the gut (Smith-Brown et al. 2016). Additionally, they observed that greater consumption of animal protein led

Results

to a decrease in abundance of bacterial species in the Bacteroides phylum, while consumption of vegetable protein (plant-based diet) was associated with a decrease in abundance of bacterial species of the Firmicutes phylum (Smith-Brown et al. 2016). Using the raw metadata from these studies, accessed through QIITA, we generated Bray-Curtis emperor plots that describe beta diversity and box plots that describe alpha diversity, the results of which are described in the following section.

Our beta diversity meta-analysis of the raw metadata from Wu et al. 2011 is depicted in the Bray Curtis emperor plot (Figure 2) and shows statistically significant clustering (PERMANOVA  $p = 0.001$ ) in the high fat and low-fat diet groups. The PERMDISP test of beta diversity came back negative, indicating no significant dispersion of metadata. One interesting thing about these results is that there was another group of clusters at the far-left

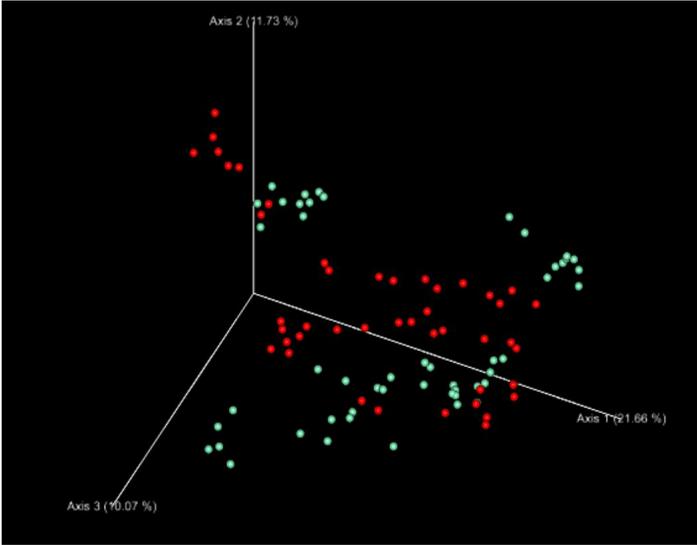


Figure 2. Bray-Curtis emperor plot of low fat (green) vs. high fat (red) groups show a statistically significant beta diversity (PERMANOVA  $p = 0.001$ , PERMDISP  $p =$  negative)

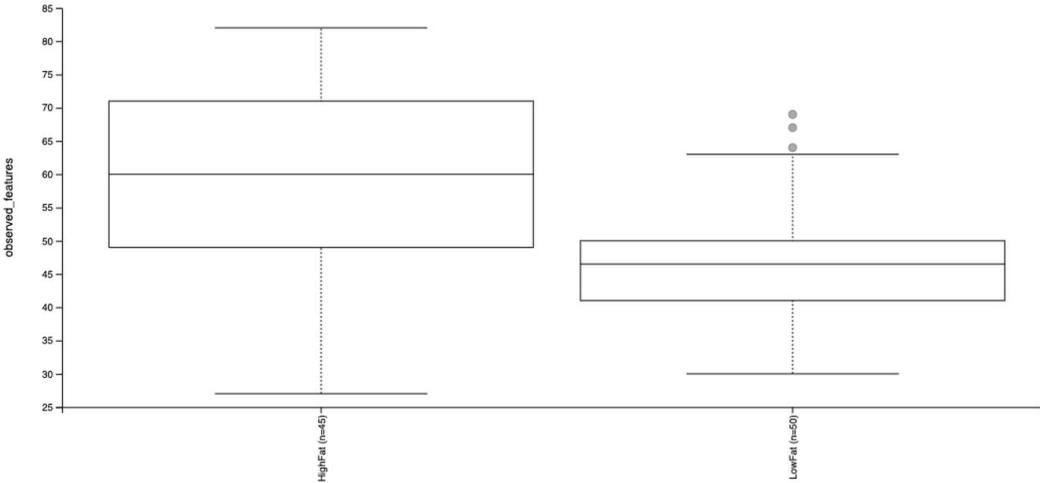


Figure 3. Observed features vector box plot of low fat (green) vs. high fat (red) groups show a statistically significant alpha diversity ( $p = 0.000$ )

region of the Bray-Curtis emperor plot (Figure 2). We investigated different categories in the metadata to see what drove this result and found that gender seemed to be the driving factor as the left clustering corresponded to samples of male participant data. Next, we ran an alpha diversity test on the raw metadata and found that a greater consumption of meat increased the alpha diversity of participants' microbiomes, as seen in the Observed Features Vector box plot (Figure 3;  $p = 0.000$ ).

We next analyzed the raw meta-data from the David et al. study. Our meta-analysis of the beta diversity of the individuals that consumed either of the two dietary groups indicated a statistically significant difference in the species richness of the gut microbiome. The Bray-Curtis emperor plot (Figure 4) showed slight clustering (PERMANOVA  $p = 0.001$ ) and obvious dispersion (PERMDISP  $p = 0.001$ ). As can be

seen in Figure 4, there is no obvious clustering in the meat-based and plant-based metadata points, but there is some dispersion in the data points that corresponds to individuals that consumed a meat-based diet. This dispersion indicates that there is more variability in the gut microbiome of all the individuals that consumed a meat-based diet, meaning that their microbiomes were more unstable in terms of species richness than individuals that consumed a plant-based diet. Something to note in the results of our beta diversity meta-analysis is that while both PERMANOVA and PERMDISP tests were statistically significant, either clustering or dispersion of data could have occurred. However, the test cannot distinguish between the two. Overall, the Bray-Curtis emperor plot more obviously indicated dispersion of data points, and, therefore, we can say that there is a statistically significant difference in the beta diversity of individuals that consumed

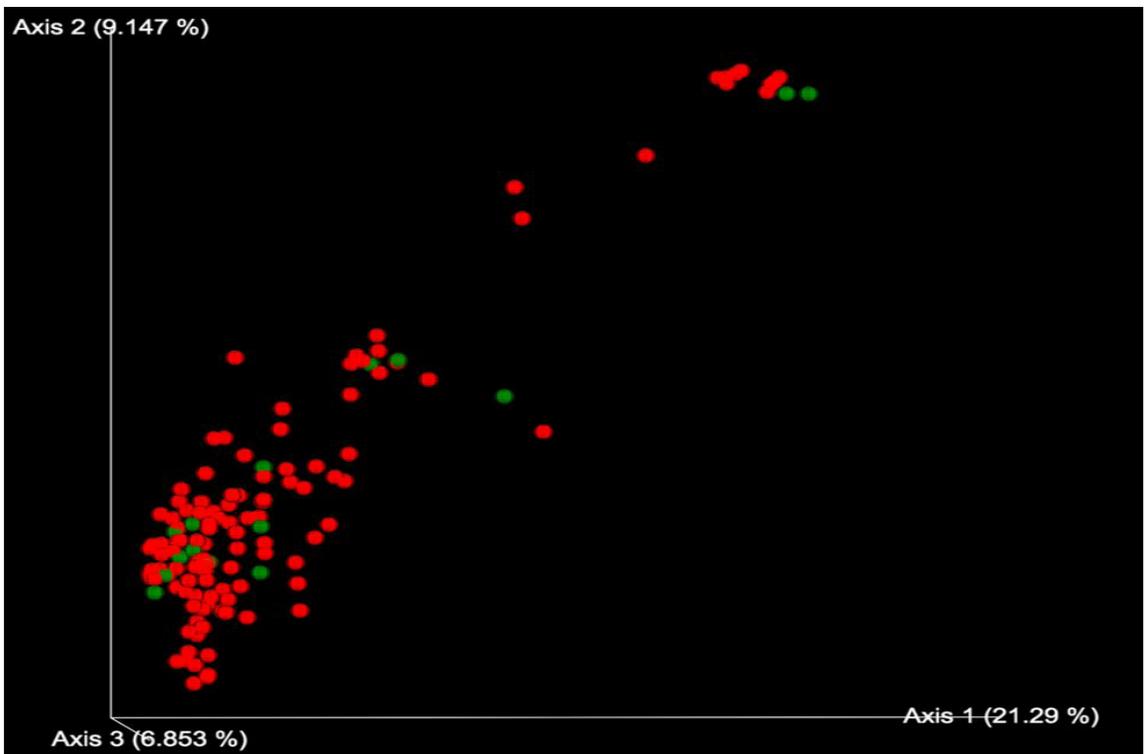


Figure 4. Bray-Curtis emperor plot of plant-based (green) vs. meat-based (red) groups show a statistically significant beta diversity (PERMANOVA  $p = 0.001$ , PERMDISP  $p = 0.001$ )

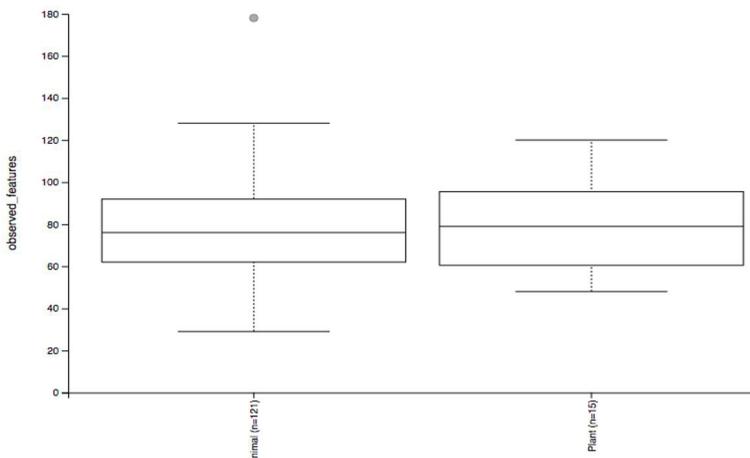


Figure 5. Observed features vector box plot of plant-based (green) vs. meat-based (red) groups show a statistically significantly alpha diversity ( $p = 9.33 \times 10^{-13}$ )

the plant-based diet and meat-based diet. We also did an alpha diversity analysis of the raw metadata and found that there was a statistically significant difference (Figure 4;  $p = 9.33 \times 10^{-13}$ ) in the observed species richness in the gut microbiomes of individuals that consumed a meat-based diet versus a plant-based diet. Specifically, the consumption of a plant-based diet resulted in higher species richness than a meat-based diet, as indicated by the median of Figure 4. The effect size of these results is small, as the difference between the median of observed species in these two diet groups examined is small.

Our meta-analysis of beta diversity using the raw meta-data from the Ruggles et al. study resulted in statistically significant results, as seen in the Bray-Curtis emperor plot (Figure 6), which showed some subtle clustering (PERMANOVA  $p = 0.001$ ) of the high meat and high polysaccharide diets and obvious dispersion of the data (PERMDISP  $p = 0.009$ ), indicating dispersion among the high meat and high polysaccharide diets. Overall, while there is a difference in beta-diversity of the data examined, we cannot formally say that there is clustering or dispersion, though the Bray-Curtis emperor plot indicated dispersion of metadata

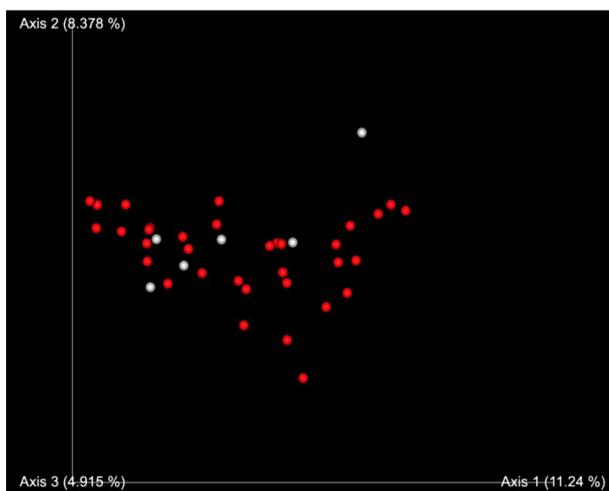


Figure 6. Bray-Curtis emperor plot of high meat (red) vs. high polysaccharide (white) groups show a statistically significant beta diversity (PERMANOVA  $p = 0.001$ , PERMDISP  $p = 0.009$ )

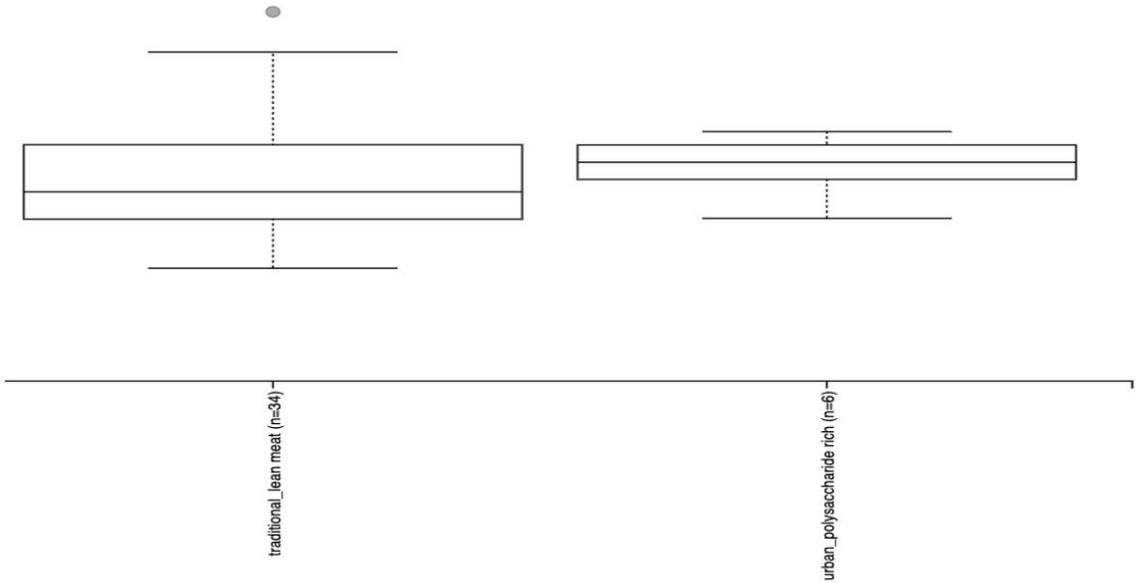


Figure 7. Observed features vector box plot of high meat (red) vs. high polysaccharide (white) groups show a statistically significantly alpha diversity ( $p = 0.0004$ )

most clearly. Next, we ran an alpha diversity analysis of the raw metadata and found that individuals who consumed a high meat-based diet had a statistically significant (Figure 7;  $p = 0.0004$ ) lower species richness in their gut microbiome compared to those who consumed a high polysaccharide-based diet. This result can be visualized in the Observed Features Vector box plot (Figure 7), where the median is lower in the high meat diet group compared to that of the high polysaccharide group, which again indicates that the species richness of the gut decreased in individuals who consumed a high meat diet.

Lastly, we analyzed the raw-metadata from the Smith-Brown et al. study. Again, we conducted beta diversity and alpha diversity meta-analysis of the raw data collected by Smith-Brown et al., the results of which came back to be not statistically significant. The Bray-Curtis emperor plot (Figure 8) showed minimal clustering (PERMANOVA  $p = 0.232$ ) and no significant

differences in dispersion (PERMDISP  $p = 0.210$ ) between diet categories examined. The alpha diversity analysis of this data (Figure 9) indicated that individuals who consumed a high meat diet had lower species richness in their gut microbiome than those who consumed a low meat diet, but as mentioned previously, this data was not statistically significant.

### Discussion

A meat-based diet was significantly associated with a decreased microbiome richness when compared to a plant-based diet. The beta group significance tests, ran for 3 out of the 4 studies analyzed, showed significant differences between the meat-based and plant-based groups based on the computed p-values for PERMANOVA and PERMDISP, and visualized by the Bray-Curtis emperor plots. The alpha diversity observed features vector box plots for 3 out of the 4 studies showed the meat-based group as having a lower median, or less

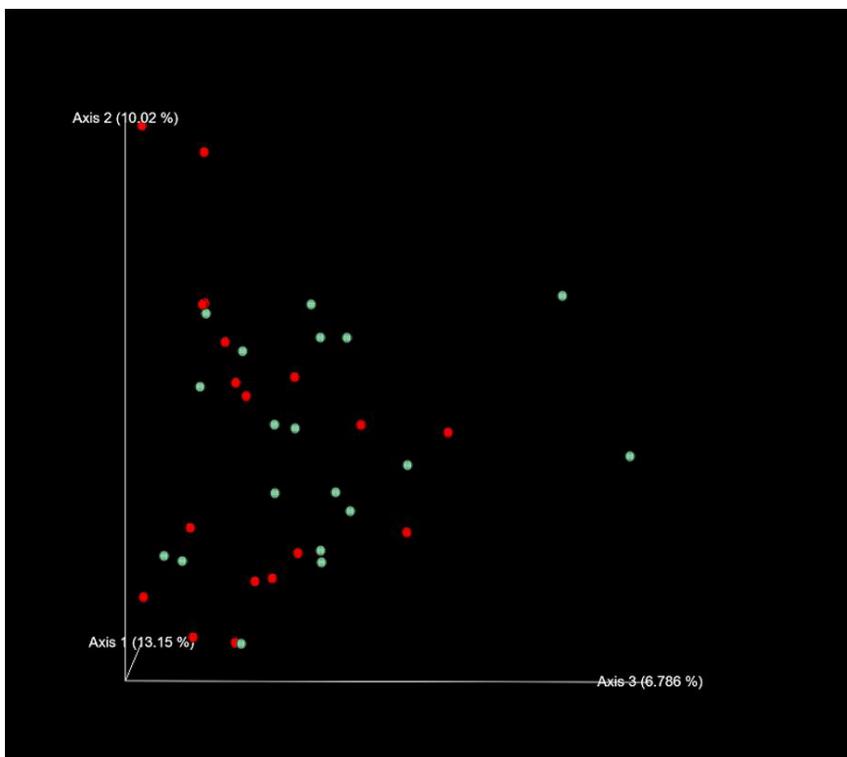


Figure 8. Bray-Curtis emperor plot of high (red) vs. low (green) daily servings of animal protein does not show a statistically significant beta diversity (PERMANOVA  $p = 0.232$ , PERMDISP  $p = 0.210$ )

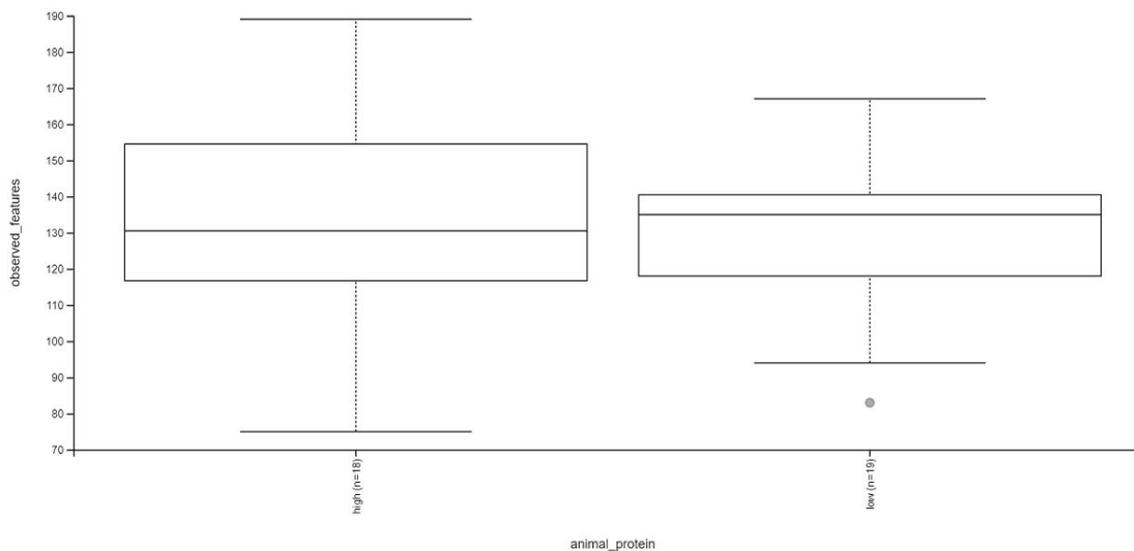


Figure 9. Observed features vector box plot of high (left) vs. low (right) daily servings of animal protein does not show a statistically significant alpha diversity ( $p = 0.964$ )

richness, than the plant-based diet group. In the high fat versus low fat analysis done, gender of participants played a role in driving clustering between the two clear clusters seen on the Bray-Curtis emperor plot. This was an interesting piece of information that was observed after sorting the data by a different category.

In regard to our results for the analysis of the raw meta-data from the Smith-Brown et al. study, there were confounding variables that were attributed to the results found for both beta diversity and alpha diversity. The participants in this study were between the ages of 2 and 3. This is of significance because during this time period, eating habits are being established that can stimulate or inhibit the growth of healthy gut flora (Smith-Brown et al. 2016). Additionally, the participants in this study did not adhere to a strict meat-based or plant-based diet; rather they recorded each individual’s daily servings of various food groups before examining their microbiome. In a future analysis, it would be helpful to conduct follow up studies on these participants as they age to see if there are any

significant changes in beta diversity based on continued high versus low daily servings of animal protein.

Our findings are consistent with what is already known about the important role diet plays in maintaining a healthy and diverse gut microbiome. Plant-based foods contain fibers that promote fermentation and increase diversity by stimulating the growth and regulation of healthy gut microbiota (Ferranti et al. 2014). In future studies, it would be interesting to see if the difference in beta and alpha diversity would be more significant between people who adhere to a strict carnivore diet versus a strict vegan diet.

In Table 1, the up and down arrows indicated in the alpha diversity column represent the high meat-based diet’s median compared to the plant-based group’s. Three out of the four studies showed a high meat-based diet as having a lower median, meaning less species richness. The negative sign in the high versus low serving’s box means that it was not statistically

Diet	Alpha Diversity	PERMANOVA	PERMDISP
High Fat (meat-based) vs. Low Fat (plant-based) Wu et al. 2011	↑	+	-
Meat-based vs. Plant-based David et al. 2014	↓	+	↑
High Meat vs. High Polysaccharide Ruggles et al. 2018	↓	+	↑
High vs. Low Number of Daily Servings of Animal Protein Smith-Brown et al. 2016	- ↓	-	-

Table 1. Summary of alpha and beta diversity analysis results for each study examined.

significant. The arrows indicated in the PERMDISP column mean that the high meat-based group had a higher significant difference than the plant-based diet group.

### Acknowledgments

We would like to thank Dr. Jesse Zaneveld for his guidance and encouragement throughout the process of data analysis and composition of this paper, the authors of the studies that we analyzed in this project for their valuable contributions to this expanding field of research, as well as our classmates for their support throughout our research.

### Supplemental Information

Supplemental data sets from the scholarly articles the authors referenced are available on our website at: <https://www.uwbcrow.com/>

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## ABOUT THE STUDENT AUTHORS

**Karenna Blomberg** is a University of Washington Bothell student who will graduate in 2022 with a bachelor's degree in Media and Communication Studies. She conducted the majority of her research while a student at Everett Community College, where she received her Associate's degree in 2019. She would like to give her enduring thanks to Gina Colantino, who mentored her during the project. Karenna hopes to be able to continue to write about the wonders of storytelling after graduation, and hopes that her work can convince its readers to think critically about the stories that they consume and celebrate their value, whatever that may be.

**Marina Burandt** received her MFA in Creative Writing and Poetics from UWB in 2020. She is currently pursuing her PhD in Literary Studies at the University of Denver. Her research interests lie in queer studies and medieval studies, and the unexpected intersections of both. Her previous writing has focused on dreams, travel, and the self.

**Luis Cruz Reyes** is an undergraduate senior at the University of Washington Bothell, currently pursuing a major in Computer science and software engineering. He is working on pursuing a career in Cyber Security and plans to graduate by 2022. In his free time, he enjoys drawing and modifying his 3D printer.

**Hielen Enyew** is currently an undergraduate student at the University of Washington majoring in International Relations and minoring in Informatics. She is currently part of the exoplanet research here at UW Bothell with Dr. Paola Rodriguez Hidalgo. She is also a mentor and a tutor to incoming and current High School students at the Alene Moris Women's Center with their Making Connections program. In addition, she volunteers at the Ethiopian church in Seattle and Vine Maple Place. She is passionate about space and space science. In her free time she likes hiking, telescope gazing, reading books, watching movies, and spending time with her family.

**Catherine Gohar** is a University of Washington Bothell senior who will graduate in June 2021 with a Bachelor of Science in Biology and a minor in Chemistry. She is currently a QSC tutor for biology and chemistry, and she conducts research within the Hillesland Laboratory as an undergraduate assistant for microbiology and evolution. Throughout the past year, she has delved into many topics, such as diagnostic tools for SARS-CoV-2, the mitochondrial evolution of sturgeons, and even the effects of wildfires and mycorrhizae on evergreen forests. She hopes to pursue a career studying infectious disease treatment and control within one of Seattle's laboratories as a research technician after graduation.

**Yazzy Ibrahim** is graduating in June 2021 with a Bachelor of Arts in Environmental Studies, Law, Economics, and Public Policy, and a minor in Human Rights. She is passionate about environmental justice and policy and hopes to join her two passions by working for an environmental department at a state/federal agency. In her free time, she enjoys listening to music, reading books, growing plants, and expanding her never ending pineapple collection.

**Jakob Johnson** is a third year student at the University Washington Bothell, planning to graduate next year with a BS in Biology and a minor in Chemistry. After graduation, he is planning on applying to pharmacy school, ultimately pursuing a career in pharmaceutical research and drug design. He is excited to be publishing again in the CROW following his 2019 publication on *Bēowulf*, *Infallibility through Duality*, and his 2020 publication on the effects of salinity on limb regrowth in starfish, *30 ppt Yields Highest Rate of Limb Regrowth In Luidia Clathrata*. In his free time, Jakob enjoys cooking, writing, and reading classical English.

**Nathan June** graduated this past March as a post-baccalaureate student with a degree in Physics. Originally from Kansas City, he has an undergraduate degree in business and worked in Chicago before moving to Seattle to work in tech-finance. Unsatisfied, he decided to change careers to something more in line with his lifelong interest in space. At the University of Washington - Bothell, Nathan has performed research with the Gravitational Wave Astronomy Research Group and the LIGO Scientific Collaboration, and served as Program Manager for the Space Public Outreach Team. For his work in the community, supporting youth from underrepresented communities as they explore STEM education, Nathan was awarded the Husky 100 recognition, and this past year he was also elected President of the campus Sigma Pi Sigma chapter. Nathan is currently seeking out physics and engineering internships to focus his candidacy as he continues to plan for graduate school.

**Karina (Aria) Xin-Yi Li** is a junior majoring in Computer Science and Software Engineering with a minor in Biology. Currently, Karina is the president of UW Bothell's Women in Science and Engineering (BWise) chapter - a club that aims to encourage and assist women in STEM. She enjoys using technology as a tool to improve and automate the world around her and always strives to continuously learn. This summer, she is excited to strengthen her skills as a software engineer by interning at Target.

**Jeffery Liao** graduates in June 2021 with a BA in Business Administration with a concentration in Management. He is very passionate about personality assessments to better understand employees and foster positive work engagement. Jeff enjoys hospitality-related fields and will be working as a Resident Services Coordinator after graduation. In his spare time, Jeff enjoys watching Warhammer 40k painting tutorials, learning about outdoor survival, and building computers.

**Joe Lollo** prefers non-gendered pronouns, is an undergraduate student at UW Bothell, as well as a media artist, a lifelong reader and gamer, and now a published scholar. They are pursuing a B.A. in Culture, Literature, and the Arts and Media and Communication Studies, based both on their love of literature and their interest in media practice and theory with new technologies. Joe is applying to graduate schools next fall and ultimately wants to pursue a Ph.D. in English with the desire to teach courses and produce academic work surrounding game studies, fan culture/fandom studies, and science fiction. Aside from this publication, they are a staff writer for *The Husky Herald* student newspaper and a research assistant with the Center on Reinventing Public Education. In line with their goal of working in academia, Joe hopes this is one of many academic articles they publish.

**Jeanne Macbeth** was born and raised in the Greater Seattle region, in the unceded, ancestral territory of the Coast Salish peoples. She is grateful to be a guest in these lands and is committed to showing solidarity for the continued fight for indigenous sovereignty. Jeanne is an artist and interdisciplinary academic, specializing in qualitative research and creative practice as a means of investigating larger social issues. She is a research assistant and graduating senior at the University of Washington, Bothell, triple majoring in 1) Society, Ethics, and Human Behavior, 2) Culture, Literature, and the Arts, and 3) Interdisciplinary Arts.

**Jacqueline R. Monteza** is a senior at the University of Washington who will graduate in June 2022 with a Bachelor of Science in Biology and a Minor in Neuroscience. Through her coursework, she has had the opportunity to explore her interests in the scientific field, and will take part in undergraduate research in the Biochemistry Department this summer. Volunteering in the ICU at Swedish Hospital has inspired her to pursue a career in medicine and she plans on applying to allopathic medical schools after graduation to pursue a focus in Neurology. She hopes that this professional role will help her better advocate for underrepresented Hispanic/Latino groups in medicine. In her free time, Jacqueline enjoys baking desserts (preferably those that include chocolate), going on hikes, and playing the piano and the violin.

**Erin Nicholson** will graduate in June of 2021 with a BS in Biology and minor in Neuroscience. She is especially interested in reproductive health and developmental biology and hopes to get into embryology after graduation. In her free time, she enjoys reading, traveling with her husband, fitness, and baking.

**YeJi Oh** graduated from the University of Washington Bothell in Winter of 2021 with a Bachelor of Science in Biology and a minor in Chemistry. She has a passion for helping others and has participated in volunteer programs from Swedish Hospital in the past. Currently, she is working as a physical therapist aide and in getting her EKG technician certificate to gain more experience in the medical field. In the future, she plans on becoming a physician assistant to better serve underrepresented communities. In her free time, she likes to immerse herself in the magical world and learn more about our wondrous universe. YeJi is thankful for the opportunity to have worked with the CROW to publish her group research paper.

**Anirudh Prasad** is an undergraduate student who is majoring in Computer Science and Software Engineering and minoring in Business Administration. He is the president of the UW Bothell chapter of the UW Blockchain Society, and is planning on graduating in 2022. Anirudh is passionate about up-and-coming technologies and is pondering pursuing research opportunities in the future. In his free time, he likes hiking and reading.

**Shushmitha Radjaram** is a junior majoring in Computer Science and minoring in Mathematics. She leads the technical side of the exoplanet atmospheres research she is a part of. She enjoys finding new ways to implement computer programming and data science in her research team's data extraction, management, and analysis processes. This Summer, Shushmitha is furthering her computer science and data intelligence skills through a Business Intelligence Engineering Internship at Amazon. She is also a dancer on Natya UW- The University of Washington's award-winning Indian classical dance team.

**Madhav Rajkondawar** is an undergraduate student who is a senior at UW Bothell pursuing a major in Computer Science and Software Engineering, with a minor in Data Science. He is the vice-president of UW Blockchain Society at the Bothell Campus and plans to graduate in 2021. Madhav is interested in building products that will make an impact in a large way in the world and the way we live. In his free time, he likes to listen to music, play outdoor sports, and watch movies.

**Annika G. Rundberg Bunney** is an interdisciplinary artist and writer from the Pacific Northwest. Her work focuses on memory and how it intertwines with imagination, history, and the environment. She is currently in her second year of a Creative Writing and Poetics MFA at UW Bothell where her thesis includes long exposure, uncertain perceptions of reality, and Edgar Allan Poe. She has been published in *Clamor* (2020) and *The Journal of Occurrences* (2018).

**Sumaiya Sathar** is a Senior at the University of Washington graduating with a BS in Microbiology and a BA in Medical Anthropology and Global Health. She works as an Administrative Assistant at the UWMC General Internal Medicine Roosevelt Clinic. She also tutors writing, chemistry, and math and teaches religious studies. Sumaiya manages a small business to help refugees and often volunteers with local schools, mosques and non-profit organizations. She is passionate about using science and technology to find solutions to global problems. In her free time she enjoys reading books and spending time with family.

**Mehran Serai** is a UW Bothell senior who will graduate in August 2021 with a BS in Biology and a minor in Chemistry. In her last year of undergrad she participated in research with the UWB Biochemistry Department. After graduation, she plans to get a job in the medical field for a year to gain experience. She then hopes to continue her education by applying to medical school to pursue a career in dermatology. In her free time, she enjoys reading, listening to music, and baking.

## ABOUT THE EDITORIAL BOARD

**Alex Blaskovich** is a third year undergrad working towards majoring in Interactive Media Design with a minor in Creative Writing. She is passionate about world building design and animation and loves to write fantasy novels in her spare time. Currently she is working as a Lead Peer Consultant at the Writing & Communication Center. She is looking forward to being a part of this year's CROW board.

**Mickena Butler** is a junior at UWB with a major in Health Studies, and a minor in Global Health. Mickena enjoys listening to and looking for good music, reading, and watching movies or documentaries in her free time. She works as a CNA caring for fragile disabled children. She loves learning about public health issues and policies from around the world. Mickena hopes to be a public health advocate whether it be as a physician, social worker, a nurse, or helping to amend or create health policies. This is her second quarter with the CROW editorial board.

**Aaron Davis** will be graduating in 2021 with a B.A. in Health Studies with a double minor in Global Health and Health Education and Promotion. Their experiences at UWB have included serving on the Health Studies Curriculum Committee, and undergraduate research assistant appointments with the Global Health department and the rHEALTH research group. Aaron believes strongly in the power of community and works as an emergency shelter manager and homeless advocate while aspiring to do participatory based research in underserved communities to aid in interventions and reduce health disparities. Aaron's enthusiasm with research writing and desire to pursue a Masters of Public Health at UW Seattle upon graduation has led them to join the CROW editorial board to learn more about the collaborative process of editing and publishing.

**Rachel Kudlacz** is a senior graduating in June 2020 with a Bachelor of Arts degree in Community Psychology. With her interest in the social sciences, she uses her skills in researching, writing, editing, and visualizing in her pursuit of presenting science as accessible and understandable for everyone; with these intentions she joined The CROW Editorial Board. At the moment she utilizes these skills as a Peer Writing Consultant at the Writing and Communication Center and as the Creative Director of the Husky Game Development club on campus.

**Jordan Nguyen** is a Junior undergraduate student currently in the Health Studies major and is working towards the Biology major. After graduation he intends to work as a medical assistant to gain experience and to eventually apply to Physician assistant school (PA). Outside his work at the CROW, Jordan is a research assistant working with Professor Stone on conducting research on racial disparities in health in order to improve population health outcomes.

**Rose O'Connor** is a second-year graduate student pursuing an MFA in Creative Writing and Poetics. She received a B.A. in English from Skidmore College in 2018 where she also minored in Management & Business. She believes our writing skills are key to how our ideas are interpreted and accepted, and she hopes to one day teach at the college level so as to help others gain the skills they need to succeed in all their pursuits. She will continue working toward her teaching goal next fall in the English MA program at Boston College. She currently works as a Lead Peer Consultant at UW Bothell's Writing and Communication Center and is quarantining with her family in Rhode Island.

**Salome Seifu** is a fourth-year undergraduate student majoring in English Literature. In her free time, she likes to play video games, draw, read, listen to music, and fantasize about worlds beyond. She is incredibly excited to be a part of this year's editorial board on the CROW. She currently works at UWB's Writing and Communication Center.

**Karina Syrova** is a third-year undergraduate student in the Health Studies major with a minor in Biology. She is passionate about research writing, and learning about effective communication and editing. Thanks to publishing last year, she was able to join the editorial board. She is excited to collaborate with other writers in the CROW's sixth volume. At UWB, Karina works at the Makerspace remotely and specializes in 3D printing. Outside of schoolwork, you might find her reading poetry or drawing.

**Shahrzad Tehrani** is a Junior at UWB working towards her BA in Environmental Studies, and minoring in Biology and Public Health. She is passionate about science communication and research writing which led her to join the CROW Editorial Board. She loves the editing process, particularly helping writers to refine their writing to effectively communicate their ideas, and is excited to work with authors to publish their work in the CROW. After graduation, she plans to work with sustainable, ethically-minded businesses, driven by her goal to increase public awareness of science and empower conscious consumption. Currently, her free time outside of school and work is spent tending to her plants, baking, and learning about linguistics.

**Christine Truong** is an undergraduate senior graduating in June 2021 with a Biology degree and a double minor in Chemistry and Health Studies. After graduating she will be applying to medical schools, continue volunteering at hospitals and her communities, and work as a medical scribe. She is an advocate for mental health awareness and takes on many roles in providing accessible healthcare for her community. She is currently the Vice President of the Biology Club and recently launched a mentorship program targeting STEM majors and supporting first-generation students. During her free time, she enjoys creating digital art and enjoying the great outdoors.

**Dacia Wagnon** is a transfer student and will be graduating with a B.A. in Health Studies in March 2021. She is passionate about students challenging and improving their written communication skills during their college career. Although public health is her greatest passion, she also deeply enjoys learning about any and all topics. Since the CROW is a unique space where knowledge, passions, and writing development intersects; she couldn't be more honored to be on the editorial board this year. After graduating, she will pursue a career as a public health professional in a role where she can advocate for female reproductive health and education access.

**Sidra Yousaf** is a second year undergraduate student currently majoring in Community Psychology as well as Biology. She intends on going to medical school and specializing in cardiology. She is passionate about social justice issues, especially those that take place in healthcare. She currently works as a Peer Consultant at the Writing and Communication Center at UWB. In her free time, she enjoys drawing and painting, as well as watching movies.