Three Inconvenient Untruths:
A Contextual Analysis of Contemporary Anti-Science in America

"What is the proof that an atom exists?"

The class remained silent long after our "Introduction to Modern Physics" professor reintroduced a timeless problem--one solved at the start of the 19th century to start our first lecture.

This question, posed to thirty of my smartest peers studying Physics and Chemistry--at one of the top science institutions in the world--generated myriad answers. Yet not one spoke to a first principles proof--with no other scientific assumptions or theories attached--that could corroborate the existence of the atom. Nobody could definitively show or understand the very essence of the fields we dedicated our education and our lives to.

This motivated my personal inquiry into this educational phenomenon--where scientific fact is known, but its reasoning is not understood. To what extent do Western educational institutions teach us facts and dogmas accepted as true without proof instead of the reasoning behind what we "know"? More poignantly still, what are the consequences of this current scientific climate?

I. Introduction

A quick survey through the annals of educational journals reveals a pertinent evolution and poignant revelation; contemporary "research" and science universities increasingly seem to be no different than theological universities of the days of old. Students are explained phenomena, frameworks, and the esoterica of their fields, but rote memorization can often leave graduates unfilled, missing something deeper (Siegel, 1989; Jacoby, 1994). While scientists, educators, and reporters unceasingly attempt truly grasp and convey the essence of their science, the meaning, and the "why" and "how" of the world around them, they've begun to present scientific arguments as religious doctrines divorced from the scientific method from which they were birthed (Roberts et. al., 2014).

This contemporary rise in dogmatic scientism overlaps with another trend: "Anti-Science" movements in radical opposition to scientific consensus are increasingly influential across the world. Ever relevant in the wake of the void of rationality left by an institutionalized "Religion of Science," these movements often appear to supplant or supercede this dogmatism, potentially offering something modern education simply lacks. This research focuses on the potential facets of pseudo-rationalities that contemporary anti-science movements offer, ultimately delving into the backgrounds and lines of reasoning underlying the trend. Specifically, an analysis of the existence of possible connections between socio-political ideals, dogmatic institutional science failures, and anti-science movements was conducted in lieu of the the rationality and reason associated with each camp.

i. Methodology

A prominent New Yorker columnist and speaker on sociological and political impacts on science, Atul Gawande directly captured and addressed the rise of anti-science movements in his 2016 Caltech commencement speech. Offering an institutional or socio-political "camp" context for their analysis, he details these anti-science communities as "multiple factions putting themselves forward…as their own cultural domains." His insight encapsulates the fundamental nature of these movements and their members, emphasizing the importance of the cultural and educational indoctrination associated with related organizations; a background fundamental to understanding, classifying, and addressing their reasoning.

In the hopes of elucidating larger trends across the entire spectrum of anti-science, our research methodology delves into three prominent theories and their movements—specifically chosen for their *distinct* organizational, societal, and most importantly political backgrounds. These three movements and their contexts—the Flat Earth movement with its lack of formal outside support, anti-vaccination with its semi-political backing, and climate change denial heavily supported by political and private sector industry groups—span the gamut of the politics and associated cultural factions that Gawande mentions.

Direct isolated injury into these distinct movements was then broken up into three main parts pertinent to analyzing their rationality as a whole. First, each group was analyzed with respect to the various facets of its background, sociological and educational context, and any larger bodies influencing these contrarian beliefs. Second, both academic articles and exhibit sources pertinent to these groups were analyzed for rational background. Looking into the reasoning or logical backing for each group, this research asked probing questions, including:

"What were the causes, the experimental background, or logical structures employed by these organizations and cultures" and "How would would a contrarian's viewpoint understand and support these claims?" While the flaws in the 'rationality' of each separate group can be (and has been) exposed in a variety of ways, disproving anti-science claims or finding holds in their logic is unrelated to the larger pursuit of this study. Notably, for the purposes of understanding the reasoning and background of movements in this research, the type of 'rationality' in this paper relates to structures of reasoning that are largely empirical or oriented around the scientific-method and corroborating facts, even if these reasoning methodologies are flawed. Thus the meaning of 'rationality' for the purposes of this study is most similar to a loose interpretation of the official Oxford English Dictionary definition: "the quality of being based on or in accordance with reason or logic" (Oxford English Dictionary, 2018). Thus, our 'rationality' is not focused on the scientific *accuracy* of a claim, but rather the scientistic reasoning and structures that substantiate it. Finally, each movement's rationality and background context was synthesized in light of the larger movement, oftentimes in comparison to outside educational and media sources' treatment of facts accepted by general the scientific community.

Ultimately, this research answered two fundamental sub-questions: first, whether each anti-science ideology can be determined to actually be rational, and if so, whether these rational movements be understood as a reactionary response or somehow correlated to the current scientific educational climate, media environment, or political culture in America. Pointed inquiry into both academic and first-hand or exhibit sources suggests that these issues strongly relate to the almost religious or partisan way students are educated, indoctrinated, or introduced to scientific beliefs.

ii. Claims

In-depth contextual analysis of these three movements, coupled with comparison of their rationality through the lens of their political affiliation, uncovered two underlying trends relating to this larger educational phenomenon:

i. First, politically charged anti-science movements evidenced less 'rationality'--as empirically defined in this paper-- in their justification of beliefs. That is, these were grounded in authority and value-oriented reasoning over empiricism or scientific logic. In contrast, movements with less formal or political backing were found to be more 'rational,' emphasizing scientific thinking, autonomy, and empirical reasoning.

ii. Second, across the spectrum of movements and the sources of their justification, anti-science citizens were subscribing to *some* form of reasoning or foundational backing to their beliefs--never in line with the true scientific consensus on a topic. This suggests a societal failure to convey the scientific foundations and rationality behind facts--directly pertaining to the current state of media and the American educational system.

II. The Flat Earth Movement

i. Illegitimate and Apolitical Support Groups

The words “Flat Earth” almost immediately prescribe a negative, often comical, stigma to a speaker, discrediting their input. Without hesitation, one’s mind can habitually dismiss this blatantly incorrect claim as irrational, preposterous, or just remarkably asinine. Yet across the world, the beliefs of the Flat Earth movement have consistently gained traction, amassing more “Flat-Earther” followers every year. In fact, online databases of search result traffic show an almost twenty times the average rise in worldwide interest and information queries in the last five years alone (2018, Google Trends). Something interesting is going on here--something relevant to the larger body of unbacked Anti-Science movements increasingly affecting our society today.

This Flat Earth phenomenon--increasing membership and traction despite incredible social stigma and no larger or legitimate organizational backing--makes the theory’s cultural domain interesting to study. This dearth of religious or political influences or organizations directly parallels a wide variety of other niche contrarian, controversial, or otherwise anti-science movements and theories across contemporary society. Even further, the international expanse and influence of the movement further isolates it from American political or organizational backing, increasing its relevance as a control group data point for comparison with more politically charged movements.

In order to understand the societal and organizational context of the movement, it is then important to understand the undeniably odd background of the movement as a whole. This background can ultimately be reduced to two parties, neither widely respected or regarded as

legitimate sources of opinion or scientific knowledge. They include celebratory endorsements and the Flat Earth Society, a grassroots organization largely connected and run by means of the internet.

Often the behavior of prominent, celebrity Flat Earther supporters suggests an unhinged mindset lacking any sort of rationality, undoubtedly mirroring the stance of many blatantly irrational Flat Earthers--thoughtless in believing a contrarian dogma. These public figures, from athletes to musical artists ultimately add little credibility to the movement and are not relevant to this search for rationality. However, certain prominent figures make a few pointed remarks that touch at some of the more rationality-oriented core tenants of the theory. For example, Kyrie Irving, a basketball player for the Cleveland Cavaliers, was asked about photographs of the Earth from space, and replied, "I've seen a lot of things that my educational system said was real, but turned out to be completely fake" (Pandian, 2017). His words mirror the more nuanced and far more structured and rationality based approach manifest in the core tenants of the Flat Earth Society.

The Flat Earth Society is the main organizational body associated with these 'anti-globe' contrarian beliefs. Interestingly, their reason, rationality, and logic-based arguments don't have to be sought after; they readily emphasize the importance of individual research and questioning everything across a variety of their informational outlets. In fact, in an interview with John Davis, President of the American Flat Earth Society, he mentions how he was led to his beliefs; as he puts it, "by [questioning]... all those things we simply accept without properly examining their logical and rational basis and foundations." Moreover, he outlines that he found that "the method used by this supposedly ridiculous group was far closer to the method of the

aforementioned [scientists] than what we see today from science as a whole. I remember thinking, 'These are people who truly value knowledge, and they do so at a real cost—social stigma'" (Whitney, 2016). Here, he touches upon the same anti-establishment sentiment as Irving, but augments this sentiment with his emphasis on the values of reason and knowledge in a skepticism oriented approach. This dedication dictates the true rationality-oriented content of the movement, and the fruits of this dedication are exactly the arguments and artifacts investigated here for their rationality.

ii. Incorrect but Undeniably Empirical

Per the rationality bent evidenced above, this research focused on Flat Earthers emphasizing rationality over blatant denialism. Members of the Flat Earth Society--facing a society that ridicules, attacks, and debases their ideas via a lack of reasoning and a position of authority--served as an excellent source of exhibit data to examine this approach. In fact, as a target of all this blatantly superficial opposition, members of the movement hold transparency, reasoning, and the act of questioning authority with the utmost regard.

Every theory has its supporting structures, and for the non-denialist Flat-Earthers, corroborating theories are easily accessible, raging from blatantly odd or sensationalist claims about the government, to detailed and intricate proofs and evidence arguments. Of these evidence-oriented arguments, some stand out as incredibly detailed, undeniably proofread, and even potentially feasible, per the efforts of hundreds or thousands of dedicated believers. For instance, Flat Earthers answer a variety of basic logistical questions about the 'edge' of their

world through use of a map, largely maintaining measurable distances, the topology and layout of continents, and any traversable distance--dictating the boundary of their edge along inaccessible Antarctic regions (The Flat Earth Wiki, 2018). Moreover, most Flat Earthers are familiar with the details of this layout--it's ubiquitous and constantly discussed, revised, and edited. This stands in stark contrast to a sensationalist survey that pointed out that 89% of Americans couldn't label Afghanistan or Iraq on a map, and over 11% couldn't label find their own country (Trivedi, 2002). Even further, Flat Earthers support their claims with a wide variety of experimentation accessible to anyone with the time and effort--not at all shrouded in esoteric vocabulary or inaccessible through expensive technology. Short lists, of these experiments, oftentimes based upon an 1881 introduction to the contemporary theory "Earth Not a Globe" by Samuel Birley Rowbotham, include up to fifteen replicable "experiments" and thirty five examples and lines of "rationality" that debunk "globe-earther" beliefs (Rowbotham, 1881). This Flat Earth manifesto, central to the movement almost a century and a half stresses "individual experimentation" and the importance that readers "well consider every point advanced" on both sides of the argument, understanding the movement's experimental evidence in full.

The movement also employs tactics and organizations, similar to citations, peer review, and scientific conferences, that exalt the almost-scientific level of rigor they employ. Interesting to note was the fact that every single page on their collective Wikipedia was backed up by, or linked to, accessible scientific evidence or experimentation--building upon their own domain of knowledge. Additionally, the internet was used as more than a medium to disperse information; the official forum of the society, various discussion oriented Facebook pages, and the Flat Earth

Wikipedia page, the phenomenon of Flat Earthers checking each others theories, and oftentimes denying other members hypothesis or experiments as too unscientific or not rigorous was easily evident in edit logs or discussions accessible to members of the society (The Flat Earth Wiki, 2018; The Flat Earth Society Forum, 2018). Members have scientific discussion, dissent, and checking measures—essentially a form of peer review—aligned in the same manner as the scientists they misunderstand and disown, showing an immense logicality and rigor in their approach to uncovering truth. They don't simply take any one group's postulations for answer; they build theories as a collective, checking the rationality of their peers and ensuring accessibility. Moreover The Flat Earth Society even holds conferences, meetings where theorists get together, discuss new theories, and review the logic and empiricism of others (Davidson, 2018). This proactive and rational peer-reviewed process has resulted in some basic tenets and supporting theories that--given their outlook and axioms on the world--serve as not only hard to crack, but also scientifically accessible to a general audience.

Overall, the movement shows immense amounts of rationality in their overwhelming, although blatantly incorrect, empiricism. Considering something against the mainstream, something against the beliefs of the masses--whether it's the shape of the earth or any new or different idea--is presented as irrational in society, while in reality this approach is fundamental to to science as a whole. It is embodied in the scientific method, fundamentally important to any sort of progress, and manifest in the Flat Earth movement--undeniably dedicated contrarians.

III. The Anti Vaccination Movement

I. A 'Semi-political' Context

In order to understand the Anti-Vaccine movement, embedded in the beliefs and teachings of odd organizational, sub-political, and sub-religious structures, it's important to note the political history and story behind it's roots. In 1993, Bill Clinton, as recently inaugurated President of the United States, submitted the Childhood Immunization Initiative Act to Congress, an immense undertaking in an attempt to raise immunization rates and create herd-immunity. Once passed as a law, this effort resulted in public school vaccine requirements for eligibility and other enforcement mechanisms to mandate vaccination in America's youth, pushing collective immunity to an all time high and helping eliminate or almost eliminate preventable diseases in the country. However, the topic of vaccination can immediately be seen to be a political rather than a completely scientific or rational motivated one.

In fact, analyzing the political and socioeconomic background of American sentiment towards mandatory vaccination reveals a clear correlation. Per a 2016 Pew research survey, while 7 percent of Americans vaccines have "high health risk", over 22 percent think immunization should be a parent's choice. The same study shows a political divide: "Conservatives (25%) are a bit more likely than either moderates (15%) or liberals (9%) to say that parents should be able to decide not to have their children vaccinated even if that creates health risks for others," (Funk et. al., 2017). This data clearly suggests that the issue of personal autonomy in choosing to vaccinate one's child--and a lack of governmental involvement in mandating or making that decision--is a highly partisan issue. Conservatives undeniably favor less government involvement in public health, despite the potential disease risks for American communities.

A different investigation on the same data, focusing on the category of anti-vaxxers who believe in the high health risks of vaccines--that 7 percent mentioned above--shows that there is, in fact, a clear political divide among the partisanship of parents. As this study finds, Americans respondents from both the far right *and* far left are one and a half times more likely to believe in vaccine induced personal harm than moderate Americans. Ultimately,t the report concludes, "It seems that it does not matter what your politics are, the more partisan, the more likely you believe vaccines are harmful" (McCoy, 2018). Therefore, anti science advocates for belief in the health risk of vaccinations don't lean politically in either direction, but rather concentrate highly at both ends of the political spectrum.

This difference in political leanings ultimately shows that the social forces and reasoning defining Americans' stances on vaccination safety are not the same as the social forces that define their stances on U.S. vaccination policy. Thus, the rationalities and justifications of both categories of anti-vaxxer parents--those who believe in the cause for political and value oriented reasoning, and those who substantiate anti-vaccination claims with potential health risks and harm--were investigated separately with respect these apolitical and political partitions to provide a clear overview of the total reasoning corroborating the occasionally partisan movement.

ii. Empiricism vs. Values - Approaches to Anti-Vaccine Reasoning

a) Apolitical and Empirically Justified

A search for dedication to scientific rationality, empiricism, and evidence in the anti-vaccination movement clearly leads to the body of social media, articles, and other literature created by those who substantiate anti-vaccination claims with potential health risks. This largely relates the incredibly right-wing or left-wing respondents who associate their beliefs with no particular political cause and are rather extreme in a wide array of their views.

The majority of these incorrect health risk-oriented claims center around past published scientific literature which anti-vaxxers uphold and understand even though all articles have been disproven by other scientific studies for a while. Many of them cite experiments, like a infamous 1998 study that outlined eight cases of autistic symptoms onset within one month of a childhood Measles, Mumps, and Rubella (MMR) vaccination (Wakefield, 1998). That these anti-science followers understand empirical experiments, and even cite these experiments to back up their beliefs across the internet--even if the experiments are terribly wrong--at the very least shows that they have an incredible inclination towards evidence based argument (Aufderheide, 2018). Even further, the science disproved scientific argument towards a vaccination induced developmental issues has since been augmented with other data by anti-vaxxers, used to substantiate their own claims of scientific correlation and causation. For instance, anti-vaxxer websites like “Mercola.com” or “VaccineImpact.com” commonly cite Center for Disease Control statistics that point towards rise in autism rates in recent years (Sophia Media, 2018; Mercola, 2018). More specifically, they juxtapose Bill Clinton’s 1993 executive order instantiating the Childhood Immunization Initiative (CII), with real statistics, including the fact that before the Immunization Initiative in 1992, only 1 in every 150 children was diagnosed with Autism

Spectrum Disorder (ASD), whereas in 2014, 1 in every 59 children was diagnosed with some form of ASD (CDC, 2018). Whether or not this correlates to better diagnosis methods is inconsequential to the fact that the causation exists, and although correlation doesn't imply causation, the axioms their movement is build upon establishes 'causation' here as an almost necessary outcome. An even better example of this scientific background is their legitimate citation of studies from the National Academies of Sciences Engineering and Medicine Department in Washington, DC that concluded "it could be dangerous for people with compromised immune systems to get the vaccine for MMR" (Koerth-Baker, 2018). This shows that even if developmental and autistic concerns do not play a factor in a health-risk-conscious parent's decision, legitimate government-verified concerns about a child's compromised immune system support their decision. They corroborate their beliefs--which is something arguably more than current sensationalist media or surface level scientific educational initiatives can claim.

Their dedication to rationality transcends simply rehashing statistics and scientific studies. Websites, like Vactruth, even list out books, from "The Thinker's Guide to Fallacies" by Richard Paul to Darrell Huff's "How to Lie with Statistics" and others to supplement their encouragement for self-research and personal engagement with inquiry and rationality (Aufderheide, 2018). This stress on the importance of truly thinking for oneself--even if that reasoning absolutely incorrectly--underscores this commitment's presence across the breadth of the health-risk apolitical vaccine believers.

b) The Moral Semi-political Argument

On the other hand the wide majority of parents who could be grouped as anti-vaxxers fell into the personal autonomy-oriented values approach to thinking about the issue. As the Pew Survey reported, 22 percent of the highly conservative respondents believed mandatory vaccination was an autonomy-oriented issue, far more than the 7 percent of respondents who supported the health risk of immunization with 'rationality'-backed arguments.

This side of the campaign can be easily seen as largely based around a personal choice regarding a parent's value of their child's life over the good of their community or American society as a whole. In fact--in this case--vaccination can be likened to a philosophical question, not easily answered by traditional scientific methods or this paper's definition of 'rationality', but rather by values-oriented reasoning—still undoubtedly rational in the broader sense of the word.

Often, they will cite scientific uncertainty in the lack of risk for children's vaccinations, but using these base level corroborated claims to lay the foundation of their argument, they turn to their own principles to back a stance. For instance, in an in depth analysis of this anti-science trend, Maggie Koerth Baker points out that there do exist "a number of potential risks that the [National Academies of Sciences, Engineering, and Medicine] don't consider proven or disproven yet" due to a lack of enough evidence in either direction (Koerth-Baker, 2018). Even further, websites for or against the the Childhood Immunization Initiative often mention that there is a well-known medical consensus that the MMR vaccine could pose slight danger to children with compromised immune systems, but not nearly the entire population (Sadaka, 2018). Moreover, when making a personal decision, the fact that most of the time the majority

of the population around one's child is vaccinated can come into play--the medical community makes it clear that "herd-immunity" protects *all* members of the population if achieved.

These axioms--spun and presented with bias--combined with a distrust for authority and attention to personal autonomy found the basis by which value reasoning corroborates anti-vaccination claims across America. Interviews with parents that apply for mandatory vaccination waivers in Michigan, conducted by Mark Largent, a professor at Michigan State University uncovered that vaccine-skeptical parents show "tremendously high trust in medical communities," and little to no trust in "the 'feds', and pharma," as presented in his book *Vaccine: The Debate in Modern America* (Largent, 2012). Additionally, in a paper in *Perspectives on Science*, Canadian philosophy professor Maya Goldenberg analyzed social-science research on vaccine hesitancy and concluded that "the conflict isn't about science," but rather "much deeper values" (Goldenberg, 2016). These parents are fighting against a health decision made for their child, and on the larger scale for their values of freedom of choice. As Koerth-Baker and Goldenberg allude to, these parents absolutely want what is best for that child, no matter the potential societal cost--and value the ability to make a choice and protect that child above anything else. It remains clear that in this scenario anti-vaccination almost becomes a personal, philosophical, or almost-political issue about valuing the miniscule risk of one's child above tangible risk for one's entire community, far beyond a scientific or empirical argument.

IV. Climate Change Deniers

i. An Undeniably Political Context

Of all the anti-science issues in the world today, perhaps the most divisive, the most widespread, and the most pressing is widespread climate change denialism across The United States. Unfortunately, this salient problem is also by far the most political--perhaps *because* it's so salient. Important to understanding the background and supporting political structures that define and propagate forward this denialism remains the history of the American Republican Party's stance on the issue, and the factors that have transformed and informed the party's stance.

The correlation between an American's conservative political stance and their views on the climate is undeniably clear. Various widely-cited sociological studies on data sets of American beliefs and political orientations point out that "the most important predictor of climate change perceptions is political orientation—political ideology and party identification," (Marquart-Pyatt et. al., 2014; Hamilton, 2011; McCright and Dunlap, 2011). In fact one 2014 study provides clear conclusion that political stance is a more important influence in climate change sentiment than exposure to or knowledge of tangible changes in climate, including extreme weather and knowledge or awareness of temperature patterns (Marquart-Pyatt et. al., 2014). These studies all rigorously show that self identified conservative and Republican citizens comprise the majority of the population who do not believe in the effects of global warming or that climate change has begun to happen at all. In fact, according to a Pew Research Center survey, only 20% of registered Republicans feel that climate change is a "very serious problem," in stark contrast with the 68% of registered Democrats (Wike, 2016). Moreover, the

current American political climate, with Republican President Donald Trump ceasing the United States' participation in the Paris Accord, and his continuous climate denialism in public statements and on his Twitter account adds to political polarization of the issue. This political involvement presents the existence of climate change not as a scientifically proven fact but rather as opinion, akin to partisan stances on domestic issues.

The factors that 'inform' this Republican sentiment, as well as general climate change denialism include the various bodies of research, propaganda, and media-driven rationality heavily funded and influenced by biased donors. In fact, more than 90% of the few scientific papers that express scepticism towards climate change can be traced back to right-wing think tanks (Xifra, 2016). It is no secret that the Koch brothers, billionaire conservatives with non-renewable energy investments, and the larger Fossil Fuels Lobby of industry representatives and advocates, both heavily donate to Republican politicians, right-wing think tanks, and niche research efforts by climate change skeptics--like the recently leaked grant for Dr. Willie Soon, an infamous skeptic in the science community. Additional investigation continues to show monetary influence and corruption exacerbating denialism sentiment. Oil, coal and utility industries have funded lobbyists in opposition to climate change with over $500 million in an 18 month period beginning in 2009 (Broder, 2010). There should be no doubt that immensely wealthy organizations--consistently those profiting off the ubiquity of this movement-- have grown, supported, and influenced the politics and research of the denialism movement.

ii. A Futile Search for 'Rational' Justification

The undeniable political tie between denialism and conservative American politics directly and dramatically reduces the rationality present in climate change deniers' justification of their anti-science belief. In fact, the large majority of climate change denialist websites contained politically charged articles and news, expressed immense amounts of anti-Democratic sentiment, and largely identified their reasoning from the perspectives of isolationist and small government Republican values. For instance, DefyCCC.com--one of the most viewed denialist-focused websites--has an incredibly politically charged bias, evident throughout their content, from the "Climate Realism. Obamanet Reversal." title in large bold font above every page, to their article, titled "Paralyzed Conservative Thought" (Goldstein, 2018). Even further, while the site states claims in their "Summary of Science" section, including "CO2 is plant food, not a pollutant," they fail to substantiate them with any sort of empirical evidence, or rationality based reasoning, but rather repeat the statement in more depth. Moreover, not a single climate change site of the top 5 most visited mentioned any semblance of experimental evidence or methodologies accessible at home or even with public data. Juxtaposing that with the fact that every single denialist website in the top 5 most visited mentions or praises Republican efforts, values, and think-tanks, oftentimes citing them as sources, underscores the political--not empirical--focus of their reasoning (Goldstein, 2018; Bast, 2016; Watts, 2018; Rothbard, 2016; Morano, 2016). For instance, The Heartland Institute's website directly states these politically charged values in their front-page mission statement: "to discover, develop, and promote free-market solutions," (Bast, 2018). Note that these websites were selected on the basis that their entire content be focused on climate change denialism, and even with this selection bias towards

more niche, focused sources over larger Republican media, this conservative values-based appeal still shows through.

Even more directly, many sociological studies inquiring into this important issue directly confirm the undertaking of this study that the leading line of reasoning of climate change deniers relates not to empiricism, but to one's values and worldview. One analysis of 25 polls and 171 studies, published in *The Nature Climate Change Journal*, confirmed that "sex, subjective knowledge, and experience of extreme weather events were overshadowed in predictive power by values, ideologies, worldviews and political orientation," (Hornsey et. al., 2016). Another study by Anthony Leiserowitz, a Human Geography professor at Yale, found that the rise in American denialism sentiment in the 2000s overlapped with the rise of the Tea Party, stating that partisan Americans "tend to listen to what their leaders say" (Leiserowitz, 2006). This behavior--defining one's stance on a topic based on political values and the words of politicians--clearly exhibits the very antithesis of empiricism or the scientific method. Maya Goldenberg, one of the professors who analyzed the value reasoning of the anti-vaxxer movement analyses and addresses climate change with the same stance. As she concludes, the climate change debate "is not about climate data." Rather, the entire anti-science issue is a proxy for debating American opinion on "how market economies ought to function, how much regulatory power the federal government should have, and what does and does not constitute undue government intrusion in daily life" (Goldenberg, 2016). Climate change denialists across America, in a grasp for better justification and support of their beliefs, turn to politics and personal values to make their opinion-based assessment of a starkly un-opinionated, scientific facts. Still, unfortunately, this value-based corroboration is not divorced from a search to find justification backing one's

beliefs; in a similar fashion to Flat-Earthers or anti-vaxxers, denialists feed their anti-science sentiment with flawed reasoning, but reasoning nonetheless.

V. Conclusion

i. Summary and Importance

Synthesis of the individual justification tactics for the three movements above directly elucidates a few overarching trends. Clearly, the three examples of anti-science movements investigated in this research--the Flat Earthers, anti-vaccination parents, and climate change deniers--differ in their respective rationales. Specifically, as the movements grow more entrenched in the American political sphere, they become less and less based in empiricism, and more and more substantiated by the values of their respective following. This trend in the politicization of anti-science is increasingly influential, incredibly pertinent, and ultimately concerning. Oftentimes the most influential scientific beliefs or movements--like the merits of vaccination or the reality of global warming--are also the most political, *because* their influence and effect can have an immense impact on society--for better or for worse. Alarmingly, the present research's conclusion regarding these politically charged and undeniably impactful movements reveals a reasoning increasingly alienated from true, scientific, or empirically-oriented thinking.

Moreover, these findings illustrate that a commitment to faulty reasoning, whether empirically rational or philosophically motivated, spans the gamut of the three causes, uniting these contrarian beliefs. Perhaps it is this commitment to reasoning--albeit oftentimes flawed or

debased--that suggests a failure in the educational system and American media environment that this research set out to study. The present phenomenon wherein individuals construct their own line of reasoning in opposition to scientific consensus seems to illuminate not only a mistrust towards the bodies that propagate forward scientific fact, but also a lack of understanding of the true scientific rationality that *correctly* justifies the scientific points they reject. Couple this analysis with academia's consensus of the existence of exacerbating scientific dogmatism in America mentioned in the introduction, and the very nature of this institutionalized failure is palpable. The vacuum of reason, a misunderstanding of true scientific method, and a deeply human desire for knowledge and certainty create the perfect, anti-science storm. In their proof-less presentation of this "Religion of Science", educators and journalists continuously fail to appeal to the rationales, purposes, and deeper, valueless minds of the citizens they inform. Ultimately, in the wake of this void of reason, one can latch on to false empiricism or value reasoning that perverts the truth and loses sight of scientific progress.

ii. Moving Forward

Max Planck--a famous Nobel Prize winning Physicist (and incidentally one of the people who discovered the current model of the atom)--once powerfully commented: "Science advances one funeral at a time."

Exceptionally dark, but incredibly relevant, Planck's comment underscores the lack of rationality across the spectrum of academia, educational institutions, and the media's approaches to contrarian movements--their attitude against contrarian ideas that hinders advancement. Here, he directly attacks the dogmatism present in his own field--a stagnancy that obstructs the

scientific method of creating new or contrarian theories and testing those ideas. Those acting outside the mainstream--against the current in an individual way--time and time again produce novel, new, and oftentimes the most important results.

Perhaps a good start to fixing the lack of correct rationality in American society is to embrace the scientific method and engage those contrarians, whether they are Flat Earthers or the first seemingly insane quantum theorists at the start of the 20th century (as Plank once was!). When engagement is lost, people continue to believe in falsehoods and lies, and a world population divorced from true, correct rationality or reason is formed. Most importantly, through this engagement, schools, news outlets, and public figures should test these hypotheses, and exalt the intricate and incredible rationality behind the correct hypothesis they put forth.

It is undeniably clear that the scientific literacy of the the human population will have an immense impact on our future as a species around (or across!) the globe. No matter the way society goes about engaging the true nature of the scientific method, this lack of tangible true rationality must be addressed. The Earth is facing the highest record temperatures in years, communities across the nation are suffering through record-breaking Measles outbreaks without herd-immunity, and influential celebrities are telling the nation's youth--our future scientists--that the Earth is flat. On top of these issues, from overpopulation to sea-level induced refugee crises, the greatest trials and obstacles in human history face us in the next few centuries. It's up to our educational systems, our understanding of rationality, and ultimately our progress as a truly rational species to make sure the next generations can understand and logically approach today's world. Only then can we face tomorrow's challenges, together.

Reflection Memo:

For as long as I can remember, science, reason, and empiricism have defined my values, pursuits, and the greater purpose I ascribe to my life. Fundamental to all three of these things is rationality, and the expression of rationality in conveying or proving ideas and understanding the world around oneself.

This research started as a personal inquiry into something I care deeply about--the fusion of these concepts with science's role in society, educational failures, and the growing number of Anti-Science movements--a trend that simultaneously fascinates and deeply unsettles me. While I had a prediction for my results at the start and largely wanted to simply learn more about the phenomenon behind these movement's rise in prevalence, my outlook, hypothesis, and then theses began to shit in a pointed and societal direction. My hypotheses changed, my fascination increased, my anger at the source of anti-science shifted, and ultimately my conclusions reflected a relationship that I had never predicted. I dove into the project, and my personal investment into the changing narrative of my research took hold.

Now, over six-thousand words later, I'm looking back with a bit of pride and a definite sense of appreciation of the task I took on. The way I think about these values and concepts that have always meant so much to me has profoundly changed. I have an appreciation for the process of actually doing research (and not just writing a predetermined paper), and an immense desire to further investigate these concepts that I care about so much. I'm even considering editing the RBA--and cutting down the research in a variety of ways--to produce and try and publish an Op. Ed. online. I haven't gotten closer to any semblance of a solution for the Anti-Science problem yet, but I now have a *strong* opinion, a deep-set personal investment, and a

realization that I'm enthralled with their analysis. Reckoning with these movements really will change the world.

Thank you so much for an awesome quarter; I ended up really enjoying PWR, and absolutely loving this research. I'm incredibly glad to have had the opportunity to take this class. See you next year!

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