The Role of Religion in the Philosophy of Science

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Introduction

"What is science, and what makes it special?" is a question that philosophers have been asking since science really took off in the 16th and 17th centuries. In fact, the field of philosophy of science is built around this question. I am not going to answer that question here, but I do want to point out an interesting thing about the ways that scholars have tried to answer it. In many of the major schools of thought in philosophy science, the theories refer to metaphysics or religion. I find this interesting because on the surface the practice of science does not seem inherently related to religion, and yet philosophies from logical empiricism (1936) to feminist theories (Oreskes 2019) have all referenced religion. In this thesis I strive to demonstrate this, explain why this is the case, and show some of the repercussions of this fact.

Much of the language that I will use to describe the way people understand the relationship between science and religion is from the work of Thomas F. Gieryn. Gieryn (1983) introduced the idea of boundary work, which is a useful lens to understand how people, both scientists and philosophers, relate science and religion. He describes how when people try to distinguish science from non-science they do boundary work, setting up ideological boundaries around the concept of science. He says that people work especially hard to do boundary work when the boundaries are important to them, and he describes three boundaries that are important for science: religion, power or politics, and engineering. Gieryn himself described how philosophers have long struggled with erecting boundaries for science, describing the work of philosophers of science as boundary work. In this thesis I will argue that the definition of science nearly always needs to appeal to a boundary with religion, and that this need makes sense in the

context of the modern history of science, especially with the developments around the introduction of evolution.

First I will ask, why is this the case? This phenomenon makes a bit more sense when put in the context of the history of modern science. In the first section of the thesis, I will examine some of this history. Most of the science in the west used to happen under the authority of the Christian church (Reuben 1996). In America in the late 19th and early 20th centuries the increasing success of science meant that it also became increasingly independent from the church. Science was generally done within universities which were predominantly Christian. Conflicts between science and theology increased as science grew, and a particularly difficult theory to integrate into the Christian universities was Darwin's theory of evolution. It is in this context that scientists began to define their field outside of the authority of theology, and connections can be drawn between the events after the introduction of evolution and the reference to religion in different theories of science.

In the second section of the thesis, I will examine key theories in the philosophy and sociology of science in order to demonstrate that these thinkers continue to reference science's relationship to religion in their definitions of science. I begin with the first true philosophers of science, the logical empiricists of the Vienna circle (Ayer 1936), who argue that science renders metaphysical pursuits as nonsense. The falsification philosophy of Karl Popper (1959) also demarcates science from metaphysics. In his sociological definition of science Robert Merton (1979) asserts that science is going to surpass and replace religion. Thomas Kuhn (1962) explains how it is difficult for him to separate science from orthodox religion, and he also works to

demarcate science and metaphysics. Finally, feminist theories of science (Longino 1987, Keller 1982, Oreskes 2019) separate science from metaphysics.

These philosophies all either make the effort to draw a boundary between science and religion, or they have a hard time distinguishing the two. These two references are two sides of the same coin; if science and religion are hard to distinguish then it makes sense that boundary work would be necessary to separate science from religion. Because of this, in these schools of thought science is characterized as not-religion. This trend in the philosophy of science shows that, whatever the definition of science really is, science itself is in some way defined by its relationship with religion, both historically and contemporarily.

Third, what are the repercussions of this phenomenon? The third and final section of my thesis will look at how scientists engage with science and religion today. I will look at Richard Dawkins and Stephen Jay Gould, who are two major scientists who speak on science and religion. Interestingly, they both study evolution, just like the history of science which pushes the boundary between science and religion. I aim to put their arguments about science and religion in the context of the philosophical definition of science as not-religion. I include this section because I would like to show the importance of this boundary in the practice of science, and in the wider world, beyond just academic theology or philosophy of science. This boundary affects how science is interpreted and what other sorts of knowledge-seeking activities mean, like studies of art, history, or philosophy.

Throughout this paper I will be referring to religion a lot. The sources I read of course did as well. However, in relation to any sort of conflict or relationship with science, often what is meant is Christianity. Since modern science emerged from within

colleges and universities that were Christian, the relationship between specifically Christianity and science in the U.S. is sometimes contentious, and that tension is what will mostly be discussed here. The extension of the relationship that science has with Christianity to other religions is not necessarily straightforward. Even other Abrahamic religions, which are also monotheistic, do not always have similar enough principles to Christianity to have the same friction with science. This is even more true for religions that are deistic or described as spiritual. Even more pressing, the power that both Christianity and science hold in the U.S. means that their relationship is different from any other religions at the time. The position of power that both institutions hold meant that there was no space for voices from other religions to chime in if it would have been important to them at all. However, in many theories of science this tension which probably arose out of the tension with Christianity gets extended to describe all religions. So, throughout this paper, as I write “religion”, I hope I can be aware of how far the repercussions of the boundary between science and Christianity extend to other religions.

The theory of evolution changed the institution of science

Science became its own academic institution around the same time that Charles Darwin published his theory of evolution by natural selection in *On the Origin of Species* (1859). The late 19th and early 20th centuries were a time of explosive scientific success, and there were many developments for the institution of science itself. However, the evolution paradigm shift in science had a strong impact on the way that science as an institution started to distinguish itself from the Christian church. This affects the way science is done and what science is and explains the resulting attempts at philosophy of science. Looking at the way scientists reacted to evolution is a good way to understand the trajectory of science's boundary with religion. Darwin's theory of evolution was a formative event in the establishment of the independent institution of science. I argue that examining the reception of evolution will demonstrate how science became defined in relation to non-scientific (religious) things.

Many historians have done a lot of work describing the history of science, and in this section, I'd like to use their work to draw connections between the events in science's history with religion in America and why the academic definitions of science reference religion surprisingly often. In Julie Reuben's book *The Making of the Modern University* (1996) she describes in detail how universities developed from Christian dominated colleges to science dominated institutions. Her book introduces us to the idea that I want to examine in this thesis in more detail: the surprising fact that academic theories of science tend to insist on a boundary between science and religion.

In the late 19th and early 20th centuries in the US, science was housed in America's colleges. However, Reuben (1996) tells us that American colleges were religious institutions with the goal of producing morally, intellectually, and spiritually

competent young men, compared to the institutions we know today, with primary goals of knowledge production through research. During the last one and a half centuries these colleges transformed themselves into institutions that valued, above all, the pursuit of knowledge via science. Science was the way to knowledge and self-formation, not religion.

Natural Theology and the Set Up of Christian Universities

Before Darwin put forth his theory in 1859, there had been other strains on the relationship between science and Christianity. Much earlier, before the scientific revolution, the people who studied nature were considered to be natural philosophers, not scientists. Natural philosophers worked directly under the institution of Christianity, so if they wanted to continue their practice, they had to be careful not to upset the church (Topham, 2010). At this point the power of natural philosophy did not really compare to the solid foundation of the Christian church. Science as we know it has a strong influence on the progress of society at large, but natural theology lacked the independence necessary to carry that burden.

The only thing that natural philosophy was able to do was to support natural theology; this is the idea that if nature comes from God, then one can learn about God by studying nature (Topham, 2010). This means that studying nature for the main purpose of supporting theology was the backdrop for the beginnings of science. At this point any attempts to learn anything, through theology, empirically, or otherwise, contributed to one unified idea of ultimate Truth held by the authority of the church. Science emerged out of a practice that was entrenched in religion. It came from a practice that used the physical to illuminate the metaphysical. The earliest secular

philosophers of science, namely the logical empiricists, would feel the need to completely separate science from the metaphysical because the development of science itself was the separation of the study of nature from religion.

It is hard to define what made natural theology turn into science, and we see this as theories of science continue to struggle with this topic to this day. In the mid-19th century when science was beginning to hit its stride and produce many convincing laws of nature, the dominant idea of science was best described by Francis Bacon who lived much earlier in the 1600s (Reuben 1996, 36). Bacon's definition of science carried over from natural philosophy to science. Bacon described science as being the pursuit of empirical facts. According to him, scientists should simply record what they find in nature. For Bacon, there are no hypotheses, only strict empiricism. Science was not trial and error, but simply gathering knowledge from the world. These facts were then used to infer laws of nature. Since Baconian science was ultimately focused on producing laws, Baconian science still worked well with natural theology after the scientific revolution because natural laws imply a law giver (39). So, the laws of nature could be used to learn about God's nature as a law giver, thus be used for natural theology.

Many of the scientific developments that came directly following the scientific revolution did come in the form of laws (Reuben 1996). Think of the revelations of Newton, Galileo, and Boyle, who produced laws of physics, astronomy, and chemistry. This idea also extends to scientific work that is about collecting and describing information, like Linnaeus with biological taxonomy, which is most relevant to the introduction of evolution by natural selection. These laws, although produced outside the authority of the church since the scientific revolution, were still easy to integrate with the dogma of the church.

Although science was beginning to get a foothold outside the authority of the Christian church, it was still being taught primarily as an important part of being an educated and good Christian (Reuben, 1996). But as science grew, the wider range of scientific fields and their increasing success, meant that it was increasingly difficult to comprehensively cover all the academic material in four years. Scientists began to worry that the strong focus on religious education was not allowing enough time for a comprehensive education in the sciences as they quickly expanded in scope. Because of the success of science, the goals of higher education shifted, and college education could no longer be comprehensive.

Darwin

Darwin proposed his theory of evolution in 1859, and evolution posed a few challenges to natural theology. It challenged theological ideas about creation and human specialness, and it also challenged the structure of science (Haught, 2000). Before addressing how the theory of evolution directly affected the way science institutionally worked, it is important to understand why it was so disruptive on an theological level.

Evolution challenged the Christian creation story itself. In his theory, Darwin implied that there was a common ancestor for all life on earth. However, a major part of the Christian creation story is that God created each animal separately, and importantly, God made humans separate from animals to watch over them. A common ancestor for life would mean that this story, where animals are created species by species, could not be literally true. Another consequence of the idea of a common ancestor is that it implies that humans are not special compared to animals. Indeed, it implies that humans are animals.

Even though the idea that the creation story was literally true was not important to all Christians, evolution also challenged theology in another way. Evolution challenged natural theology. The theory of evolution states that animals change over time, so laws about taxonomy were no longer fixed. Biology used to focus on taxonomy: making laws about which organisms belonged in which groups. But now those laws could not be final. The groups of animals and plants would change over time which means that, if there are no laws to be made, there is no evidence of a lawgiver. Thus, evolution makes it more difficult to use science, especially biology, for natural theology (Haught 2000).

These issues meant that it was a struggle for theology to adapt to evolution. Even though many ultimately successful theologians and scientists integrated evolution into their theological worldview, the magnitude of the upset caused by the theory of evolution is important to keep in mind as we interrogate its effect on the structure of science.

Because evolution challenged natural theology, Darwin also challenged the mutualistic relationship between Christian universities and their science departments (Reuben, 1996). The problem for theologians at universities was that, even though Darwin's evolution was not in the form of a final law, it was still scientifically compelling. In Darwin's *On the Origin of Species* (1859) he proposes the law of natural selection -- a theory about how animals become adapted to their environments. Unlike the laws of physics or chemistry though, Darwin did not have a mathematical or physical proof for his theory. Darwin's theory of evolution was inspired by examples from nature, the most famous being Darwin's finches in the Galapagos. He observed that the finches on each island had beaks to match their food source, but otherwise were similar. He

proposed that the birds with the best beaks would survive long enough to reproduce and pass on their beak shape until the whole population had specialized beaks; this was his proposed law of natural selection. However, Darwin did not know how the traits would be passed down because he did not know about genetics. There was no proof for his theory, there was only support from his examples.

Rather, the purpose of the law of natural selection was to give a hypothesis that might guide further research. This means that the idea of natural selection, that the animals that are the most fit for their environments survive and pass on their abilities, is meant to be a framework that can be used to understand many different organisms. Rather than a final ruling, it was just an idea about Darwin's observations that turned out to be a useful tool to think about why organisms are the way that they are. Although there was, and continues to be, increasing support for an idea of evolution like Darwin's, the way that it was introduced without an air of true finality, but leaving room for further discovery, was the main difference between Darwin's evolution and classic Baconian science.

Evolution encouraged scientists to begin focusing on making and revising hypotheses, rather than the Baconian way of determining strict natural laws (Reuben 1996, 39). Even though scientists were used to the classical law-making nature of science, eventually they were won over by the persuasiveness and usefulness of the theory of evolution. This new hypothesis-driven scientific environment no longer supported natural theology. The goal of science was no longer gathering facts, rather science became a process for understanding those facts. With science like the theory of evolution, there is more acknowledgement of the constant potential for being wrong. We have seen the merits of this attitude because declared laws often get overturned, like

Newton's laws being replaced by Einstein's. For theologians, more speculative science was not well suited to support the goal of learning about God himself, but it could only serve the weaker goal of learning about God's world. This weaker goal was not enough to hold science and Christianity together in education or research at universities. Thus, evolution was part of a shift in scientific method that increased the strain between science and the religious universities that it belonged to.

It is this newer method of science that modern philosophers of science are attempting to define. The rift from natural theology, but with a continuing appeal to empiricism might have produced some cognitive dissonance. The same empiricism that used to support natural theology now is unable to do so. Keeping empiricism as the focus of science, but changing the shape of science around it produced a slightly different version of empiricism. This new empiricism supports a humbler ongoing process of science that no longer declares "Truth." This empiricism needed to be separated from religion while the old one did not.

In the attempts to resolve the dissonance between theology and science, most discussions among scientists and theologians focused on the methodological differences between science and religion. Unlike laws, hypotheses change over time, and scientists felt this was in direct opposition to the dogmatic nature of religion (Reuben 1996, 51). According to some scientists, where science allowed for changing understandings of truth, religion stuck to dogmatic understandings. Many scientists also began to stress the separate spheres that science and religion occupy. Science was supposed to study the natural and come to definitive conclusions, while religion was supposed to study the supernatural and express itself through symbolic language (52). Religion explored primary (metaphysical) causes, and science studied secondary (physical) causes. For

many scientists of the day. the more speculative and malleable science that emerged after Darwin did not lend itself to conciliation with the established Church education. A new boundary around science began to be drawn based on these distinctions. Reuben tells us that the scientists involved in constructing this boundary did so by describing science and religion as "separate spheres." (52). The idea of separate spheres is echoed throughout not just philosophy of science but also most descriptions of science and religion even today. However, even though this is such a common modern understanding of science and religion, it seems to be so important to science that even when science is not being compared to religion it still comes up occasionally.

In the 1870-1890s theology began to be removed from the curriculum of major universities (Reuben 1996, 88), a physical manifestation of the newly separated "spheres." This meant changes not only to science departments, but also many of the other parts of the university as well, particularly philosophy and religion. In the interim time between the decrease of natural theology and full secularization, major universities were very careful to hire philosophers who would not stand against Christian ideals, but who were not indoctrinated enough to be free thinkers (90). Additionally, religion classes, which previously taught theology, began to study religion itself, like modern religion departments (95). The overthrow of strictly Baconian science, in part due to the theory of evolution, not only changed the structure of scientific investigation, but also the types of research done by any department of the university. Newer universities were no longer participating in theology, and they were not outrightly involved in studying the metaphysical.

In the place of religion, science became the center of universities, and the epitome of good research (Reuben 1996). Even though science became the central focus

of universities, universities did not immediately stop being institutions for moral education. Instead, people turned in part to science as a way to teach morality; scientists thought that the solid mental skill of doing science would lead to stronger moral clarity (Reuben 1996, 135). This also leads to science having moral value in and of itself. The progress of science symbolized the progress of humanity overall (137).

This notion of the importance of science, and that it represents progress, is echoed throughout philosophies of science as well. In the next section I will highlight the parts where some of the major schools of thought in philosophy of science reference religion. Along the way there will be evidence of the lasting effect of science replacing religion in Christian universities. The specific relationship with Christianity often gets generalized to religion, and the threads of science's place center stage and its relationship to religion become intertwined throughout the philosophical shape of science.

Inclusions of Religion in Philosophies of Science

The center of philosophy of science is the question "What makes science science?" Although scientists probably don't think about it that much, the answer to this question affects their whole careers: their funding, their departments, their work, and its impact. Philosophy, sociology, and history of science are fields devoted to answering that question. "What is science, and why does it work so well?" Both philosophy of science, established in the early 20th century, and sociology of science, which came quickly after, came with many answers to this question (Godfrey-Smith 2003). In many of the major theories, part of defining science meant separating it from religion or metaphysics, as I will show in this section. As I will demonstrate, this suggests both that there may be something about science that is similar to western religion and that philosophers of science have been particularly anxious about distinguishing science from religion.

In general, most of these definitions define the goal of science as producing truth. As a quick overview of epistemology, one of the strongest arguments for the definition of knowledge is that it is justified, true, belief. So, as I talk about the goals of science, seeking knowledge and seeking truth are meant synonymously.

There are two main ideas about the essential part of science: one is that science has a special method; the other is that science has a particular social structure. I argue that these two perspectives engage the boundary between religion and science in distinct but related ways. Writers who appeal to a special method stress that their method only examines the physical and not the metaphysical (Oreskes 2019, Ayer 1936). Writers who appeal to a special social structure relate that structure to religion in some way. Either by saying science will replace religion (Merton 1973), or by saying it is difficult to make a

rule distinguishing science's structure from orthodox religion (Kuhn 1962) and must establish the difference. Taken together, I interpret this to mean that overall, in order to define science, there is something about its structure that warrants distinguishing it from religion. These philosophers and sociologists demonstrate the ways that science is still influenced by the Christian universities it was a part of, even after scientific investigation became independent of the church. By examining the work of some of the major philosophers and sociologists of science I want to demonstrate the ever-present connection between science and religion. We can see how the similarities between the institutions of science and the church contribute to a definition of science, to some extent, as not-religion.

With this in mind I will go through some of the major ways to imagine science, one from many of the major schools of thought throughout the last century. For each school of thought, I will describe the proposed goal of science, the proposed method, and how these philosophies discuss religion. I will show how defining science seems to require some boundary work around religion.

Logical Empiricism

Empiricism was one of the first philosophies of science, it was held by Compte, and later developed into a school of thought called logical positivism by a group of philosophers called the Vienna Circle, including Hempel, Carnap, and Ayer (Godfrey-Smith 2003). Other philosophers like Karl Popper responded to the Vienna circle with another sort of empiricism. Empiricism is the idea that all knowledge is derived from sense-experience of the world. For empiricists there is only one way to gather knowledge, which is to interact with the physical world in order to draw

conclusions. Positivism is the idea that every justifiable idea is either empirically verifiable or mathematically provable. Logical positivists argued that there are two ways of increasing knowledge. The two ways are both logical and include deduction, which is a logical proof (like math), and induction, which is the logical process of turning empirical information into truth statements.

The basic premise for logical positivists is that the only way to gain knowledge about the world is through empiricism, and this is the definition of science. So for these philosophers, gaining knowledge via physical evidence meant that speaking of the metaphysical was nonsense. A member of the Vienna Circle, AJ Ayer (1936), wrote "The Elimination of Metaphysics" as the first chapter in his book *Language Truth and Logic*. On the first page he asks the metaphysician what evidence they have for their conclusions (Ayer 1936, 4). He says, "Must he not begin, as other men do, with the evidence of his senses?" He argues that since the only method of gathering knowledge is empiricism, even a person who thinks they are doing metaphysics is still only making conclusions from the physical world. For Ayer, all learning is empiricism, and thus all learning is science.

Popper (1959), who disagreed with logical positivism, proposed a new empirical logic of scientific knowledge called falsification. The basic argument is that induction can never lead to certainty because no amount of evidence can lead to absolute surety, but falsification can lead to certainty because finding one contrary case permanently negates an assertion. The classic example is that no matter how many swans you see you cannot prove that "all swans are white" because you cannot see all of the swans. However, the assertion "all swans are white" can be proven false by finding one black

swan. Popper points to the faults of Baconian science, arguing that it is difficult to make laws based on empiricism.

Popper (1959), in introducing his new logic, contributes some attempt at demarcating science from metaphysics. He disagrees with the logical positivist assertion that metaphysics is nonsensical and suggests that although some metaphysics is necessary for the development of scientific knowledge, ultimately the best way to get knowledge is through empiricism.

The demarcation of science from metaphysics is a part of both logical positivism and Popper's falsification. It is interesting that for the empiricists, not only is science different from metaphysics, but they go further to say we can only gain knowledge through observation of the physical; any religious pursuits of the metaphysical are nonsense. This is a rather central point to their definition of science. This makes sense because it is one of the earliest schools of thought, and it came of age shortly after science became independent from Christianity. Although it was not the center of their philosophy, these theories of science blatantly defined science as not-religion. They say that science is not-religion (and in fact is better than the metaphysical parts of religion) because it uses the only viable method for gaining knowledge.

Merton and Sociology of Science

Robert K. Merton was one of the earliest sociologists of science. He worked during the same time as philosophers of science like logical empiricists and Karl Popper with falsification, but Merton took a different approach to explaining the authority of science. His sociology builds upon the work of the early philosophers of science, but it attributes the authority of science to its social structure rather than purely its method.

One of the important pieces that Merton (1942) wrote is “The Normative Structure of Science,” in which he explains the four values that allow science to function. The values are universalism, communism, disinterestedness, and organized skepticism. Because Merton begins this essay by discussing science’s triumph over religion, and because he uses morals to define science, throughout his writing he is subtly doing boundary work to differentiate science from religion.

In “The Normative Structure of Science” Merton (1942) says, “The institutional goal of science is the extension of certified knowledge.” However, unlike many other philosophers and sociologists of science, it does not seem like Merton strictly means justified, true, belief when he says knowledge. He later says that the statements produced by science are essentially predictions, rather than true statements about the world. This goal is a little more specific than the general idea of seeking truth, but it still involves seeking truths that are helpful in making predictions. This echoed the type of science that Darwin was doing. Natural selection was not a declaration of truth, but a hypothesis about how life evolves, ultimately a prediction that would gain more support. This type of truth was still set up in opposition to metaphysical and specifically religious truth, as will be clear when looking more closely at Merton’s proposed structure of science.

Merton proposed that the goal of scientific knowledge, combined with the empirical methods of science, produce a set of values or norms that guide science. The values were an efficient way to ensure that the empirical and systematic method of science is carried out. These values were set up in opposition to the church, yet some of them also had a structure very similar to the church. The idea of opposition is a demonstration of defining science as not-religion.

In the introduction of "The Normative Structure of Science," Merton (1973) described how science emerged out of religion. He explained that science used to need justification either from the church or from utility: either to glorify God as seen through creation or to provide important and useful things like medicine and machines (268). However, Merton said that as science became more successful, it no longer needed external justification, and now it could be justified in and of itself (268). According to Merton, science became an institution that was separate from religion—and in competition with it. This suggested that science is a replacement for religion, or at least was a competing institution. This sentiment had been around before Merton. It brings to mind Marxist humanistic atheism which predicts that science will replace religion completely in the future, and Merton does cite Marx several times in this piece.

In the next sentence of the introduction, Merton describes science as "in society but not of it" (268). This is highly reflective of the Biblical sentiment that Christians should be in but not of the world, inspired by Christ's statement in John 17:11, 14–15. This reflects the similarity between Merton's idea of science and Christianity, which he must have purposefully emphasized. It also helps us to understand how the institutions could be seen as completely isolated, both thinking of the other as part of "the world" which it deems itself separate from. The idea of being "in but not of" also implies a certain amount of authority, at least in Christianity it evokes commands for Christians to be examples of virtue to the world, and it is not hard to see science as the prime authority of knowledge in the world. Here Merton makes it clear that an important part of science is its difference and importance over the Christian church.

Finally, Merton's emphasis on values heavily reflects the church. He argues that science is united by shared values, rather than a shared goal, which is much closer to

religion than the science described by many other philosophies of science. Merton goes further to suggest that the values he proposes are not only useful but also morally good (270). Merton's proposed values are universalism, communism, disinterestedness, and organized skepticism. Universalism and communism have some similarities to Christian values. For Merton universalism means that the product of science, the knowledge produced, should be applicable anytime and anywhere. Ideally, science is true for everyone. Some Christians say the same about their own truths; that ideally their message should apply to everyone.

Communism in science means that truth is not defined by any single person, it is the production of an entire field, and it belongs to everyone. Again, this is similar to some sorts of Christianity, including Protestantism that was dominant in the US in the early 20th century (Jones 2021).

Disinterestedness in science means that scientists should not have any investment in the conclusions that they make. This is distinctly different from the truth discussed in organized religion where truth is for and about the people that take part in its production. While the first two values are reflected in Christian values, disinterestedness emphasizes that science is different because it is objective.

The last value, organized skepticism, means that scientists should not make conclusions until they are certain that they are true. They should not jump to conclusions or allow conclusions to persist just because they are good. Again, this value implicitly emphasizes the way that science does not bend to the people who do it. While religion might make people feel better, science is objective.

Overall, his survey of scientific values emphasizes that while science may have the overarching social power of religion (communism and universality), it is objective unlike

religion (disinterestedness and organized skepticism). Merton does not show that scientific pursuits logically negate any religious metaphysical pursuits like the empiricists did, but like the empiricists he does emphasize that science surpasses religion. Both schools of thought demarcate science and religion, and both insist that science is superior. In these schools of thought, science is outrightly described to be in some ways similar in theoretical shape to religion, but also different in some important ways.

Kuhn: Scientific Revolutions

Thomas Kuhn published the book *The Structure of Scientific Revolutions* in 1962, and it changed the field of philosophy and sociology of science and played a big part in beginning the field of science studies. Kuhn was a historian, so the book is a mix of history, philosophy, and sociology of science. Later in his career he clarified and refined the points he made in this book, but still, it is an important text in science studies. Kuhn coined the phrase paradigm shift, where paradigm means a conceptual framework that scientists operate within. The paradigm sets up the questions to be asked and makes up the rules for answering those questions. In his book he describes his idea that science functions in an upward spiral of normal science and revolution, where revolutions change the paradigm in a field. During normal science, scientists work on solving puzzles set up by the current paradigm, but eventually there is too much anomalous data for the puzzles to account for, so a new paradigm is required, and a revolution happens. Some examples of revolutions are Einstein's relativity or Darwin's evolution (although Kuhn never mentions Darwin in *Structure*).

Like many philosophers, Kuhn sees the goal of science as the pursuit of knowledge. However, he sees the progress of science as away from untruth, rather than towards truth. This is similar to Popper's philosophy, where scientists eliminate false beliefs. Kuhn states this simply by saying as science progresses, we get an "increasingly detailed and refined understanding of nature" (Kuhn 1962, 169). Kuhn seems to think that science is not about seeking any metaphysical truth, but just truth about nature. He does, however, say that scientists need to have "quasi-metaphysical" beliefs to understand a paradigm, giving the example that physicists need to have a belief about what the universe is made of in order to do empirical physics. Using Kuhn's ideas, we would demarcate science from religion based on subject rather than the validity of their goals or the method they use to achieve them.

There are many places in *Structure* where I find striking similarities between how Kuhn describes science and how the church works, and this points to the fact that science is the sort of thing that needs demarcation from religion. Throughout the book Kuhn talks about scientists experiencing a conversion when they change paradigms (1962, xxxi, 150, 78). He describes how, when scientists are faced with a new paradigm to understand their field, they cannot help but accept it. He emphasizes that it is not really a choice that scientists make. When they are faced with a new paradigm it is like they have a gut feeling about it or it feels so right, or they cannot accept it because they simply cannot see things in this new way. The conversion can be induced by forces outside science as well. Even beyond conversion, he explains that science is not prescriptive, it is a way of seeing (85). Kuhn actually describes the early stages of a paradigm shift as an act of faith, explaining that a scientist must commit to seeing the

world through a new paradigm before it has been tested, because it can only be tested by looking through the new paradigm (158).

Conversion and faith draw a connection to Christianity. Kuhn saw the ways that science functions like religion at least during a paradigm shift. But in addition to that, Kuhn himself, in attempting to describe how science is special compared to other fields, finds it hard to separate science from religion (135). Part of his attempt to demarcate science from other fields is a focus on the rigid way that science is taught in order to separate it from other fields. Science education happens mainly through textbooks, and students are not expected to really engage in the actual practice of science, like designing new experiments or reading primary literature, until they are in graduate school beginning their own careers in science. For Kuhn, this rigid education sets up students to work within the existing paradigm, teaching them to see the world through the lens of the paradigm. Other fields encourage more free thought early on because they do not have a paradigm to work within, instead they have many ideas and no consensus. However, Kuhn says that the only field which rivals science in the rigidity of education is orthodox religion (165). This makes sense. Religion too is a field where the goal of education is to produce people who see the world a certain way. Kuhn has a hard time coming up with a definition of science that does not include religion, even though he can exclude many other fields. He says that science's revolutions most clearly distinguish it "from every other creative pursuit except perhaps theology" (135). By Kuhn's definition of science, religion is found right on the edge of the boundary around science.

Although Kuhn does not find it necessary to dismiss religion, like the previous two philosophies do, as he makes his argument he continues to struggle with the

boundary between science and religion. Not only that, but he also describes a science that sounds similar in some ways to Christianity as acts of faith and conversion. This demonstrates why he would have a difficult time differentiating the two, and why he needs to address the difference in his theory of science. Kuhn's lens for understanding science can further illuminate why it is difficult to make a theory of science without grappling with the boundary with religion. Kuhn describes science through its structure, and since he has the hardest time separating this structure from the structure of religion. Part of defining science is explaining how it is different from other fields, and since Kuhn describes science as similar, in some ways, to religion, he must also emphasize that it is not-religion. Like with empiricism and Merton's sociology we see that the similarities between science and religion warrant mentioning religion in the definition of science.

Feminist Theories of Science

Feminist theories of science, as described by Helen Longino, Evelyn Fox Keller, and Naomi Oreskes, all describe the state of science today, criticize it, and discuss how it should be improved. In science, there are different levels of feminist critiques which are well described by Evelyn Fox Keller (1982). On the most basic level, what she describes as politically left of center, there is the critique that a majority of scientists are men (590). Slightly further to the political left, is the argument that this gender imbalance affects what sorts of science gets funded, especially in medicine with issues like birth control and menstrual cramps being neglected. Even farther left, there is a critique that the androcentric bias in science affects not just the problems that are focused on, but also the methods of the experiments themselves, with the example of only using male

rats for medical experiments. Most deeply, feminist critiques point to the nature of science as objective and therefore masculine, and suggest that science is not, and cannot nor should be, objective.

It is at this deepest level that a feminist philosophy of science appears. The feminist portrayal of science as it harkens back to the empiricist emphasis on objectivity and logic. These feminist theorists tend to argue that science views itself as objective and holds itself to that standard, and that this standard is characterized as male (Keller 1982, 593). However, feminist theories also point out that science is not objective in the first place. It is in fact a value laden field which is affected by its political context (Longino 1987) and acknowledging this fact will allow us to be properly critical of the perspectives allowed within current androcentric science and more fairly include new feminine and feminist perspectives.

Longino (1987) discusses metaphysics as she points out that science is value laden. She argues that science progresses and changes our understanding of nature itself, for instance, what counts as data and what counts as interpretation changes over time. This relativity is made clear in the example of evolution. Until genetics was combined with the theory of evolution, evolution was more of an interpretation of taxonomic data than a truth about nature. Now taxonomy is done using evolutionary theory, and the intellectual frontier of evolution is in genetics. Evolution which was once just a good idea had become the backbone of the field. The interpretation has become the data. According to Longino, because of this there is inherent relativity in science, and so a scientist must assume that their framework is true (like Kuhn's paradigms) to practice any kind of inductive logic. These assumptions, for Longino, are metaphysical or value laden (55).

Harding (1982) also describes science in a way that reflects the relationship between science and religion. She describes how objectivity gets characterized as male and subjectivity as female. Like Longino's work, this subjectivity involves values and metaphysical assumptions, which sounds similar to religious pursuits of truth. She shows us that the characterization of objectivity and subjectivity as male and female means that they are understood as opposites and thus there can be no mediation between the two (594). This relates to the idea of science as objective and religion as subjective and that science and religion belong in separate spheres. In these theories when objective science and value laden metaphysics are understood as male and female, they become irreconcilable just as we saw in logical positivist understandings of science. But, these gendered characterizations of science and values or metaphysics are questioned, and some theories show that these feminine and masculine aspects of science can and should be reconciled.

Oreskes (2019) gives us an explanation of what a reconciled science would look like and why it would make science better. Her theory is supported by ideas from feminist standpoint epistemology (Narayan 1988). Standpoint epistemology is the idea that people who are othered have a more accurate understanding of the system they are othered by. This idea first came up in Marxism, where the proletariat have a privileged view of capitalism, and so have more accurate knowledge of its flaws and ultimately the ability to dismantle the system. Feminist scholars later applied this idea to gender, describing how women have a better perspective on gender, and therefore also capitalism, since capitalism is a sexist structure. This epistemology has been used to understand race, disability, sexuality, etc., and generalized to say that different people have different perspectives on things, and this may give them privileged knowledge.

Based on the idea that different people have different kinds of privileged knowledge, standpoint theory entails the conclusion that a diverse group of people will be able to come up with more objective knowledge than a uniform group.

Oreskes (2019) argues that with an understanding that science is inherently value laden, and that we cannot practice science outside of a perspective, we should appreciate that diverse perspectives will allow us to approach objectivity (57). For Oreskes any empirical practice is science, and empiricism practiced through many perspectives begins to resolve the biases of androcentrism in science (or indeed racism, homophobia, and ableism as well).

In these theories, central to their critique of science is that science excludes metaphysical and value commitments where they really exist. Part of being critical of science was to point out that it does not acknowledge its metaphysics. Again, we see the relevance of mentioning metaphysics in defining (and ultimately critiquing) science.

Concluding thoughts

In each of these theories the authors talk about metaphysics or religion. In empiricist schools of thought there is a lot of talk about metaphysics, and much of the definition of science is based on its distinction from metaphysics. In Merton's sociology of science, he makes it clear that science is not religion, and in fact it may replace religion. In Kuhn's book, although he seems to easily distinguish science from other fields, he says that it is hard to distinguish it from orthodox religion. In feminist theories of science, we see that science as it is rejects the subjective and metaphysical parts of itself that would be characterized as feminine, and that this causes problems within science.

There are two main ways that religion comes up in these philosophies and I argue that they are related. The first way is that philosophers simply define science as not-religion, like the empiricists. The second way is that philosophers have a hard time distinguishing science from religion, or somehow mention their similar structure, like Merton and Kuhn. The first more directly supports my argument. Being not-religion is a fairly important part of science's identity. However, many of the philosophers point out that science has a similar structure to religion. I argue that this similar structure is *why* philosophers must make efforts to separate science from western religion.

Taken altogether, these trends over many philosophies of science indicate something important about science. Even if none of these philosophies successfully define science, the trend of consistently referencing metaphysics or religion can still be meaningful. The trends lead us to believe that science truly has an important relationship with western religion, and so it makes sense that an important part of defining science would be demarcating, or more extremely eliminating, religion. However, because science and religion have this close relationship, their interaction continues to be important. Science's definition as, in part, not-religion has important effects on the relationship between science and religion. These effects have important implications for all areas of academic study as well as for science itself. In the next chapter I will show how the nature of science as partially not-religion affects its relationship with religion today.

Modern Understandings of Science and Religion: Two Cases

Today, the relationship between science and religion comes to a head not just in philosophy but also in popular culture and within science itself. Several prominent scientists have spoken on the relationship between science and religion. Why is it that scientists continue to engage so loudly with this boundary? After all, it is not the job of a scientist to do philosophy or theology, and the conflict with science and Christianity has been resolved in numerous ways (although there are still those who maintain that there is a conflict).

As demonstrated, there is a complicated history between science and religion, especially around evolution, in the U.S. However, much of this conflict has been resolved both in theology and for religious scientists. Even though 30% of scientists are Christians (Liu 2009), practically no scientists have a problem reconciling their faith with evolution (Ecklund 2010). Although the Christians who are anti-evolution are loud and sometimes influential, they are actually a minority of Christians in the U.S. (Pew Research 2015). Any conflict around evolution and religion in the U.S. is rather inconsequential to the practice of science.

However, within academia, there is a sizable minority of scientists who think there is an irreconcilable conflict between science and religion (15-36% depending on how the question is framed) (Ecklund 2010, 19 & 91). On the other hand, a majority of scientists find that religion and science belong in separate spheres (Ecklund 2010, 97), each covering a different domain and not interacting with the other. These are the two dominant views about religion and science held among scientists.

Here I will use two prominent scientists, Richard Dawkins and Stephen Jay Gould, who have both spoken on science and religion, as case studies for scientists' current ideas about the boundary between science and religion. These scientists are both well established in their fields, and often cited on the relationship between science and religion (Horgan 2015). Both of these scientists also happen to study evolution: Dawkins is a biologist and Gould is a paleontologist. These scientists end up with different models of the relationship between science and religion, but I will argue that these models can both be explained by examining them from a philosophy of science perspective, and that they point to the larger impact of the not-religion part of the definition of science that is not-religion.

A common thread through this paper has been a focus on evolution. Not only was much of the history covered in this paper about the introduction of the theory of evolution, but also two of the most famous scientific speakers on science and religion are evolutionary biologists. In her history of the modern university, Julie Reuben (1996) partially focuses on the impact of evolution in the formation of scientific universities out of Christian universities. Stephen J. Gould (1997) writes about how the boundary between science and religion often happens around issues affected by evolution. He writes about how the metaphysical issues most important to people are the ones about themselves. Do people have souls, are people special compared to animals, etc. These issues are all challenged by implications of evolution, just like we saw in previous chapters as evolution was being introduced for the first time.

Gould (1997) provides some insight as to why evolution is often found at the center of this discussion. Even though all physical things have metaphysical implications, for example in astronomy/physics asking whether the universe is "in"

something, or what happened before the big bang. Even if the answer to these questions is nothing, these questions are metaphysical because they make claims about what metaphysics is or is not true. The metaphysics that are most important to us tend to be about us. It makes sense that much of the boundary work between science and religion would happen around scientific theories that are relevant to personal metaphysical issues, like who we are and why we are here, which tend to be related to evolution.

Motivated by opposition to the small but loud group of fundamentalist Christians that are anti-evolutionists, both of these scientists give their accounts of what the relationship between science and religion should be. Dawkins puts forth an argument that science and religion are incompatible. Gould argues that science and religion are separate and non-overlapping. Since, as we have seen, a part of defining science is excluding religion, I will argue that these two different models for science and religion can be explained in the same way. As evidenced by the many academic definitions of science that reference religion, there is an important part of science that has a boundary with religion. This boundary, which can be explained through the history of evolution and Christianity, is also evident in the current views on science and religion.

Case Study: Richard Dawkins

Richard Dawkins is an evolutionary biologist who is also the author of many popular science books. In science, he is famous for his idea of the selfish gene, a theory of evolution where genes are the actors in evolution rather than individual organisms or populations (Dawkins 2016). He is also famously a champion of the view that science and religion are separate, and that science renders religion irrational.

To illustrate Dawkins' take on science and religion I will begin by using a children's book he wrote called *The Magic of Reality* (2011) where he basically makes his argument for science over religion in a format which is accessible to young readers. In the first chapter he talks about three types of magic: magic like wonder, stage magic, and supernatural magic. He says that stage magic is fun, the magic of wonder is beautiful, and supernatural magic is dangerous. Dawkins defines "supernatural" very purposefully. He includes fiction, myths, fairy tales, and miracles in the list of supernatural magic (Dawkins 2011, 20). He says, "Indeed, to claim a supernatural explanation of something is not to explain it at all and, even worse, to rule out any possibility of its ever being explained" (Dawkins 2011, 23).

In this book, Dawkins gives some examples of miracles that he thinks people foolishly believe in. All the examples in the first and last chapters are Christian. In order to make this line of reasoning work, Dawkins uses a narrow view of religion as evidenced by his focus on Christianity. His view of religion is one of a personal God. He clearly states that he means the sort of God of the Abrahamic religions: Christianity, Judaism, and Islam. Although in his writings that are explicitly about religion like in *The God Delusion* (2006) he mentions all three, in his other books which are supposed to be more about science than about religion his critiques of religion are very directed at the Christian God (Dawkins 2011). However, his arguments get extended to all religions, but it makes sense that his arguments would work best with a God like the Christian God because of the history of science.

Like the logical empiricist argument, instead of struggling with the boundary between science and religion, Dawkins eliminates religion altogether. This is accomplished by his rather radical (re)definition of religion. Many scientists, even those

that do not practice an Abrahamic religion, describe their experience with the spiritual using the word religious. However, for Dawkins religion is defined as supernatural as opposed to scientific. In the first chapter of his book *The God Delusion* (2006) he writes:

> "The metaphorical or pantheistic God of the physicists is light years away from the interventionist, miracle-wreaking, thought-reading, sin-punishing, prayer-answering God of the Bible, of priests, mullahs, and rabbis, and of ordinary language. Deliberately to confuse the two is, in my opinion, an act of intellectual high treason."

He argues that religion, as the word is commonly understood, is belief in the latter theistic and personal God. The religion described when scientists describe spiritual wonder evoked by science, the religion referenced by famous physicists like Einstein and Stephen Hawking, is meant purely as a metaphor and is not truly religious. In this sense he defines religion as not-science and as irrational. For Dawkins (2006), the word religion is never accurately describing anything other than theistic or perhaps deistic belief (18).

Perhaps Dawkins is correct that when many people say religion, they mean a personal God that can be prayed to. But importantly, people like Einstein and Hawking also describe their spiritual beliefs as religion, but Dawkins describes their beliefs as science, something that most scientists would disagree with. It is striking that Dawkins describes their spiritual experience as science, not simply by separating the spiritual from the religious. Many scientists would say that they are spiritual but not religious (Ecklund 2010), but Dawkins' ideas do not leave room for spirituality either. For Dawkins all valid beliefs must be scientific, so spiritual experiences about science are part of science, not separate from science. This is something that most scientists

disagree with, most tend to say that the spiritual belongs in a different realm than science (Ecklund 2010).

Dawkins' theory that religion is nonsense is directly reminiscent of logical positivist definitions of science, where science is all encompassing. The logical positivist theory made historical sense because it was written shortly after science settled into its place at the center of American universities, replacing religion. The nature of science was changed as it came closer to the center of knowledge-pursuits. This nature is reflected in the way that Dawkins' theory is shaped. For Dawkins too, science is the epitome of truth-seeking, so much so that it eliminates others. The weight of the elimination is evidenced by the major effort taken to communicate it, and it is so important to Dawkins because science is defined against religion, so religion must be addressed when defining science.

Why does Dawkins in particular feel the need to be so outspoken about science being rational and religion being irrational? What about religion does Dawkins find so threatening? Dawkins is an evolutionary biologist and is often speaking either explicitly or implicitly about creationism versus evolution, which is interesting in the context of the history that played a big part in defining science against religion. In his children's book (2011), Dawkins explains the failures of supernatural explanations by illustrating evolution as a complex and beautiful process and emphasizing that any story which insists that life appeared spontaneously is foolish and lazy (31). It makes sense that creationism would frustrate Dawkins: the idea that despite massive evidence of evolution people still cling to older explanations for the origin of life is frustrating when that is one's life's work. If Dawkins thinks that science is the epitome of reason, and the

religious people most relevant to him do not believe in evolution, which is Dawkins' work, then Dawkins could feel that religion is irrational by generalizing his experience.

However, only 18% of Americans believe that humans have always existed in their current form (Funk, Smith, & Maski, 2019) while about 75% of Americans are religious (Pew Research, 2015). In fact, depending on the way the question was framed, only 38% of evangelical Christians believe in creationism (Funk, Smith, & Maski, 2019). Practically no scientists at major universities believe that humans have always existed in their current form (Ecklund 2010). Creationism is not really any threat to the practice of science, and people who believe in creationism are a minority (albeit perhaps a large one).

So, although it might make personal sense that Dawkins would be upset by creationism and its threat to science, in practice it does not seem necessary. It is not just that religious people are ignorant or foolish that motivates Dawkins, but his idea that religion is bad for society. From the outside, Dawkins' rather aggressive boundary work is, perhaps, less warranted than it might seem. But understanding the importance of the boundary between science and religion around evolution, and understanding how the institution of science, in part, came out of a struggle about evolution which made the boundaries of science most delicate there, can help us understand why Dawkins' drastic redefinition of religion makes sense.

In his work Dawkins is very adamant about religion being completely irrational, and upholding science. He also argues that religion is morally bad for society and science is good. Although Dawkins' stance, by his own definition, is non-metaphysical, choosing to believe only in a physical reality is itself a metaphysical commitment. It is not possible to separate science from metaphysics and it is important to consider them

together. If, as I have shown, metaphysics and values are such an important part of science, it makes sense that being passionate about science would entail holding passionate metaphysical and moral commitments. In this case study, the fact that science is defined in part as not-religion is made clear, not only because there is an aggressive dialogue around science and religion, but also because we see that advocating for science as good involves metaphysical commitments. We see the repercussions of this through Dawkins' insistence that science is the best way to learn, which lessens other areas of knowledge seeking like religion, of course, but also things like art. This stance renders all attempts at learning that are not strictly science as lesser because it makes science morally good; a stance that would not be as likely if the nature of science was not related to religion.

Stephen Jay Gould

Stephen Jay Gould is a paleontologist who is famous for his theory of evolution by punctuated equilibrium, an update to Darwin's idea of natural selection. He is also a writer of popular science books and has written several books about science and religion. Within the context of science and religion, he is famous for his theory which he calls non-overlapping magisteria (NOMA for short). In short, in this theory Gould states that science and religion have their own domains which do not overlap and cannot interact, but they exist peacefully together in people's lives. In fact, Gould is one of the most widely cited scientists in the world on this subject (Horgan 2015). He is a very similar figure to Dawkins, both study evolution, introduced a landmark evolutionary theory, are authors of popular science books, and are outspoken on the issue of the relationship between science and religion. This makes them an excellent comparison.

Gould's theory of science and religion as "non-overlapping magisteria" is succinctly defined in his book *Rocks of Ages* (1999). First, the definition of magisterium is, as Gould stresses, not related to majesty or majestic (the root with a j in maj), but it is instead "a domain where one form of teaching holds the appropriate tools for meaningful discourse and resolution" (Gould 1999, 5). He further explains that each magisterium has its own rules and admissible questions, as well as its own ways of judgment and resolution (52-53). So, for Gould science and religion each occupy their own magisterium, and these domains do not overlap; one cannot interfere with the other. Science cannot answer the kinds of questions that religion asks and vice versa. Both domains limit the scope of their conclusions so that they fall within their own boundaries, what Gould describes as a mutual humility (10). Each domain can stay inside its boundaries, and they can peacefully coexist.

Gould defines the magisterium of science as the domain that deals with matters of fact, ultimately meaning truth. He says these are the questions that in principle can have "yes or no answers" even if in practice those answers are difficult or impossible to achieve (Gould 1999, 53). Gould defines the magisterium of religion as the domain that deals with "the value and meaning of life" (55). These are the questions that can never have a final answer. He emphasizes that not all of the approaches within this magisterium are called religion, but he thinks the name is appropriate because the label "religion" is used to describe this domain within most cultures (58). He also says that the magisteria of science and religion do not comprise all kinds of questions that can be asked and answered. Gould gives the example of art as the domain which asks and answers questions about beauty (6).

Before discussing how this theory makes sense in the context of the philosophical definition of science as not-religion, there is one final thing to say about Gould's NOMA theory. What does this look like in practice, and how do they coexist within the minds and lives of the people that practice within these magisteria? Gould says, "the contact between magisteria could not be more intimate and pressing over every square micrometer … of contact" (Gould 1999, 65). Even though Gould argues that these domains are logically separate, he insists that they are integrally interacting over every interesting problem (65).

We saw that theoretically it is difficult to define science without a reference to religion, here in his more practical advice about science and religion we see the repercussions of that theory. For Gould, science and religion must be separate in order for them to interact. In Gould's theory we see how the interface between science and religion is so important, and exciting even, but that they are separate because of their topics. If science is "not-religion" like many philosophers say it is when they try to define science, and we allow religion to exist unlike the logical empiricists and Dawkins, then this makes sense as a way to relate the two. Gould describes the logically distinct line between science and religion as complex at "every fractal scale of self-similarity" (Gould 1999, 65). This is to say that they are separate and yet still when you start to try to define religion and practice them together the interface is infinitely complicated. Gould's description of science and religion reflects how science and religion are the same sort of thing (magisteria), but about different things (truth vs. value & meaning). Gould's theory can be explained by the definition of science as not-religion which I demonstrated is repeated over and over again in philosophies of science. If science is

truly shaped in part as not-religion, then we see the repercussions of this in Gould's theory.

Gould interestingly points out that evolution pushes the borders of both science and religion. He (1997) describes how, "Many of our deepest questions call upon aspects of both [science and religion] for different parts of a full answer". He gives examples about evolution. The first asks, since we are the only species to evolve advanced consciousness, what are our responsibilities to life on earth? The second asks, what do our evolutionary relationships with other organisms mean for the ultimate meaning of life? This is especially interesting if we put the definition of science in the context of its recent history. As I discussed in the first section, evolution played a fairly major part in the institutionalization of science in the US. Science was shaped by the religious conflict over evolution which influenced science's definition. Even though the conflict around evolution has died down, the definition of science itself has held onto traces of the historical contention. This definition is still apparent in the relationship between science and religion according to Gould. Based on Gould's theory, the repercussions of the definition of science are that science and religion cannot overlap, they cannot answer the same questions.

Conclusion

A part of the institution of science is that it is not-religion. I wanted to show that this is true, why it is true, and that it has important repercussions for science. I demonstrated that modern science was partially born out of the tense relationship between the Christian universities and science which was aggravated by the introduction of Darwin's theory of evolution. Because science took the place of religion at the center of universities there are similarities in their structure, yet they need to be differentiated. So, it makes sense that part of defining science would be separating it from its religious predecessor.

I demonstrated that this boundary work remains an important part of science by showing that, in the many ways that people have tried to define science or explain why it is so successful, philosophers include boundary work around religion or metaphysics. I find this surprising because the definition of science seems like it should be about the methods, social structure, or subject of science, all of which do not immediately seem like they should be related to religion. This trend shows the lasting impact of the complex relationship between science and religion. The very structure of science carries with it something that is so importantly not-religion that this is addressed over and over.

Finally, I showed that this is apparent in the relationship between science and religion today. Two scientists, Richard Dawkins and Stephen Jay Gould, both do the same kind of boundary work as the philosophers when they try to navigate the relationship between science and religion, but in different ways. Their conclusions point to why this aspect of science matters.

The theory of evolution was central to this argument. Not only is the theory of evolution an important development of science in the last two centuries, but it also continues to be cited as an example by some of the scientists who are most outspoken about science and religion. Why is this? Darwin's theory of evolution by natural selection challenged the churches by moving into their territory. Darwin's theory attempted to explain the natural world rather than just describe it. And his idea of natural selection threatened to replace God as the creative mechanism in nature. When this happened, scientists also described their explanations as better than religious ones because they were less "speculative" or metaphysical.

So why does it matter? It matters because it shows that our definition of science is intrinsically linked to religion as a concept. Religion here extends beyond the monotheistic Christianity that was a part of the universities in the early 20th century, but also deistic religions and religious stances like agnosticism and atheism. Science and religion's shared past, as well as science's re-institutionalization because of a struggle over the boundaries of science and religion, leaving us with a science is not-religion in a way that means it is also not-metaphysics and is amoral.

This restricts science's abilities. If we take a page out of the feminist theories of science, we learn that failing to acknowledge the metaphysical and value laden nature of science can mean that we fail to see the biases in the science that we are doing. Feminist theories particularly point out the androcentric nature of science, but there are many other aspects of science that go unnoticed if we do not stop to think about how science is entangled with religion. There are the Christian values that originally contributed to this entanglement. There are also potential racist, homophobic, and ableist biases that will go unnoticed because of privileged groups in the U.S. If we can acknowledge that there

is a part of science that entails metaphysical commitments, the part that requires boundary work with religion, science can expand its horizons and be more purposeful about including other perspectives, and so strengthen the consensus that provides science with such success.

Science's boundary with religion also affects the topics that it can cover. There are many topics that fall on the boundary between science and religion that get neglected. Science is a highly funded field, and topics that can be called science become important because of that label. In many places there is ambiguity about whether a question counts as scientific. These places often fall on the line between science and religious topics. Questions of human values and morals either fall into the category of anthropology or theology/religious studies. Questions about what it means to be a person or to be conscious fall in between cognitive science or psychology and philosophy or theology. Questions about what the universe is made of fall between physics and metaphysics or theology. At the edges of science, we see topics that fall on the line between science and religion. Topics that involve supernatural phenomena that are not well understood like spiritual healing, ESP, spirit possession, ghosts, and UFOs are often laughed off specifically because they deal with metaphysics. Depending on what side of the boundary between science and religion these topics fall, they might be over or under studied. What gets funded as science depends on the definition of science, and since we see that the definition of science has something to do with being not metaphysics or religion, this definition is important for choosing topics for science.

These topics might practically matter. For instance in anthropology, we might want to know how to make international laws that should apply to every culture. In cognitive science we might want to describe when artificial intelligence has achieved

human-like intelligence. The answers to these questions might also come from other fields. Yet the funding, publication, and readership of these different kinds of research might be different. The fact that science is not-religion does not only blind us to biases in science, but also directly cuts off types and topics of research that can and need to be done.

A final broad effect of this special aspect of the definition of science is that it limits other fields of knowledge besides science itself. This is demonstrated particularly through the last two case studies. At worst, as we see through Dawkins' case, science's power renders other fields as lesser or false. If science is not-religion, and science is the best or only way to find truth then the things in other magisteria, to use Gould's term, are either irrational or irrelevant to learning new things. If science is defined against religion, and it is considered superior, then we cannot learn through art, through stories, or through religion, because these things entail the non-physical. Learning about beauty without art, the experience of life without stories, about values and morality without religion (or other metaphysical commitments) sounds impossible, and to call this sort of learning science (as Dawkins would have us do) sounds incorrect, yet this is the consequence of his definition and positioning of science.

At best, as Gould's case shows us, the strict demarcation of science, particularly around religion, makes it difficult for science to interact with other fields. If part of the reason that science holds such a place of power in both academia and beyond is because it became the center of universities by demarcating itself from religion, then the boundaries around it mean that it is hard to do interdisciplinary work with science. This is because science is so strongly defined against other fields, especially those that involve value and metaphysics like religion but also art and storytelling.

Science has brought us a lot of important knowledge: medicine, infrastructure, communication, and vast knowledge of the world we live in. It has affected, and improved life for many people in many ways. However, because of the success and power it has, the boundaries of science have a wide effect, extending far past the scientists who practice it. In some ways science is defined by its boundaries, and part of its definition is that it is not-religion. We see this repeatedly throughout philosophy of science. We see it in the recent history of science, and we see it in the relationship between science and religion today. We also see how practicing science without acknowledging its inherent definition that is in part metaphysical can lead to bias in science, limitations of the subjects of study, and weakening of other fields. If we are aware that science is not-religion, we can do better science, and learn more truth in general. Science's definition does not just affect the work of philosophers, but it reaches into the world as far as science does. That is to say, far.

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