Let There Be Light:
An Argument for the Possibility of Paradigm Change through Debate

by

Ronald J. Ross III

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In 1962 Thomas Kuhn argued that scientific revolutions occur through paradigm change. That is, the model for the way we understand the world is completely replaced by a new incompatible model. He also claimed that these revolutions are non-cumulative, and thus there is actual incommensurability between the paradigms. However, by stating the process of revolution in such an exaggerated manner in order to highlight the non-cumulative nature of paradigm change, Kuhn precludes the possibility of revolution through debate. I argue that a close examination of the works of Francis Bacon as well as a scrutiny of Galileo and Priestley reveal genuine areas of rationally adjudicable, commensurable agreement. Furthermore, I posit a process, based on the ideas of Willard Von Orman Quine, whereby we might actually affect revolution, in whole or in part, through the process of debate.
Let There Be Light: 

An Argument for the Possibility of Paradigm Change through Debate

About four hundred years ago, western society entered into a period of scientific revolution. The scholastic natural philosophy of the Middle Ages was proving increasingly incapable of satisfying the inquiries of what we would label today as the scientific community. The investigations of thinkers such as Robert Grosseteste and Roger Bacon, although certainly important, were no longer producing sufficient results. Consequently, the British crown gave Francis Bacon permission to pen texts concerning the state of natural inquiry. Although Bacon certainly knew he was trying to affect some kind of change, it is uncertain whether or not he recognized that his Magna Instauratio (or Great Instauration) expressed a transformation to a completely new kind of investigation.

Now, these four hundred years later, philosophers are working to understand how these kinds of revolutions proceed. They are trying to figure out the how, why, and what results from the revolutionary process. In 1962 Thomas Kuhn penned one of the most important works in this field, The Structure of Scientific Revolutions. Among other things, Kuhn asserted that scientific revolutions involve complete paradigm changes in the way scientists perceive the world. This claim leads Kuhn to assert that there is complete incommensurability between the paradigms. To put it another way, the practitioners of different paradigms may be able to understand each other in the simplest sense, but they could not rationally adjudicate competing claims. Kuhn then asserts that the switch to another paradigm occurs by demonstrating the paradigm through its basic functions, not through using arguments for that paradigm. The
reasoning is that as groups employ their paradigm to argue in favor of their paradigm, debate is effectively curtailed because groups lose the common language that argument necessitates.

However, I contend that although the majority of Kuhn’s framework is correct, he is mistaken on this point. Certainly incommensurability between the paradigms is important to understand how scientific revolutions are noncumulative: they do not build on the previous science. Yet, employing such strong views on communication muddles what is actually going on in the periods of revolution; it precludes debate as a method to affect paradigm change. Shifts from one paradigm to another do not involve learning an entirely new language, but rather a persuasion to new understandings of many familiar words and concepts. Although some expectations of words may be entirely new in a different paradigm, I believe there are enough common expectations between the two groups’ lexicons that they are able to persuade the practitioners of the old paradigm to a new point of view. By exaggerating the issue of incommensurability, Kuhn does not allow debate to bring about paradigm change.

Yet, an examination of Francis Bacon’s writings during the Scientific Revolution reveals the possibility of commensurability between paradigms. The manner in which he attacked the lack of utility in the sciences as well as the inadequacy of the syllogism demonstrates the manner in which he worked to retain areas of rational adjudicability with scholasticism. Even more, a close reading of the term “light” reveals that he uses the concept of light to establish common referents with the scholastic natural philosophy while simultaneously attaching new significances to these words that only work in the Baconian paradigm. Further study of Galileo, Priestley, and Lavoisier underscores the possibility of commensurability during periods of paradigm change. Kuhn’s point is useful, but he goes too far. By employing the language theory of Willard Von Orman Quine, I will show how it might be possible to affect a whole paradigm shift on the
grounds of debate. While incommensurability might be useful when thinking about the products of revolution, by invoking it during the entirety of the process, Kuhn shuts off an important avenue for paradigm change.

**Revolution and Incommensurability**

In his conceptual framework, Kuhn wants to argue that changes in scientific practice are genuine revolutions; it is not just mere coincidence that we have titled them such. Kuhn desires to show that there is complete discontinuity with the past rather than a simple alteration of the framework while leaving the basic structures in place. To put it in historical terms, Kuhn has something in mind that is more like the Bolshevik overthrow of the Czars than the Colonies’ revision of British democracy. In scientific terms, it is a move from a geocentric to heliocentric worldview rather than a move from nine planets in our solar system to eight. For Kuhn, revolution necessitates complete discontinuity with the past thereby resulting in periods of scientific activity that are non-cumulative with past practices.

In order to get to this point, Kuhn must posit that there is complete incommensurability between the competing models. For these episodes of change to be really, completely non-cumulative, the practitioners of either paradigm must not be able to rationally adjudicate competing claims similar to the way a Czarist could not adjudicate a Bolshevik’s views on social justice or a heliocentrist a geocentrist’s conception of the movement of planets (Kuhn would claim). This assertion then leads to Kuhn to claim that persuasion to a new model must occur through demonstration and not debate. A Bolshevik could only demonstrate to a Czarist how Marxism is superior; he could never explain to him why that is the case. Similarly, a heliocentrist could never convince a geocentrist that the sun revolves around the earth through
conversational persuasion. He would have to demonstrate the superiority of his model experientially.

In Kuhn’s language, these models are called “paradigms,” and Kuhn believes that science acts through the “priority of paradigms.” When he uses “paradigm,” Kuhn means, “accepted examples of actual scientific practice—examples which include law, theory, application, and instrumentation together—[which] provide models from which spring particular coherent traditions of scientific research” (10). For instance, heliocentric and geocentric conceptions of heavenly bodies both constitute examples of paradigms in the Kuhnian sense: they are models of the way the world works. Although both conceptions are wholly different—heliocentrists believe the Earth revolves around the sun where geocentrists hold that the sun revolves around the Earth—both ideas still possess law, theory, applications, and instruments that work within the paradigm, whichever it might be, to create a coherent scientific practice. Kuhn’s idea is that our paradigm is that which serves as the basis for all of our scientific inquiries; it is the concept behind the experiments, not the experiments themselves. We view the world through the understandings of this paradigm and all knowledge occurs within the parameters of its understandings. It is important to notice here that when Kuhn refers to “actual scientific practice” within the concept of a paradigm, he does not just mean practice in the sense of “action” or “doing.” Rather, paradigms are supported just as much with the language of law and theory as they are by actual demonstration.

Kuhn then believes that revolutions occur whenever the present paradigm is incapable of accounting for a considerable number of anomalous events (events that scientists cannot rationally account for given the current paradigmatic framework). As he explains, “Confronted with anomaly or with crisis, scientists take a different attitude toward existing paradigms . . .
scientific revolutions are. . . [then] those non-cumulative developmental episodes in which an older paradigm is replaced in whole or part by a completely incompatible new one” (90-1). For instance, when a geocentric system was no longer able to account for, say, the variability of seasons, scientists had to find a new way (read: heliocentrism) to do so. In order to give this account, Kuhn contends that the shift to heliocentrism had to be “non-cumulative,” that is, it could not rely on the “law, theory, application, and instrumentation” of the previous, geocentric paradigm. In a sense, scientific practice in a specific field or subfield completely reorders itself by not resting on the previous foundations. The present paradigm may be cumulative with itself, but it must be noncontinuous (non-cumulative) with the previous paradigm. The result of revolution is that the new paradigm (heliocentrism), as engendered by a theory that was non-cumulative with the past science, is “completely incompatible” with the old paradigm (geocentrism).

Some thirty years later Kuhn delved deeper into how language functions during periods of revolutions in the anthology *World Changes*. For starters, Kuhn identifies important terms for understanding his position on the incommensurability of paradigms. The first is a “lexicon,” which, he writes, is “the module in which members of a speech community store the community’s kind-terms” (315). Kind-terms for Kuhn include both natural and scientific kinds and may be identified according to Aristotle’s idea of substance. Kind-terms are “things that, between their origin and demise, trace a life-line through space and time” (315). Thus, kind-terms are broad concepts like “force” and “government” that allow us to recognize certain category schemes. From these schemes we are able to determine whenever individual particulars, or as Kuhn puts it, referents, fall into a particular category and to project what kinds of referents might fall into that category.
Kuhn then goes on to explain the three characteristics of kind-terms. He believes that they are learned through use, they are projectible [sic] such that knowledge of a kind-term allows one to know some characteristics of its referents, and the expectations of a kind-term supply users with the meaning of the term (316-7). The idea of an expectation is that whenever a speaker uses a kind-term, he gestures toward certain referents about which the listener expects the speaker to indicate. What the listener expects the shared behaviors and characteristics of the referents to be, the things that are projectible, is that which actually endows the kind-term with its meaning. For instance, we learn the kind-term “planet” through use; it is not something we inherently know, but rather something we come to understand through the give-and-take of our education. Furthermore, once we know “planet,” we can project what we expect certain characteristics of its referents to be: round bodies larger than asteroids or comets which orbit a star but do not act as satellites for any other body. Lastly, whenever you say “planet,” I expect you to mean these characteristics, and this expectation is what supplies the term with its meaning. If you said “planet” and expected me to have the previous characteristics of referents in mind, but I actually was thinking of heavenly bodies that contain energy and can determine destinies, then we have a serious breakdown in communication. Kuhn then elaborates on this last implication by writing:

Changes in a kind-term’s referents are therefore changes in its meanings, so that only a limited variety of expectations may be accommodated within a speech community. So long as two community members have compatible expectations. . . there will be no difficulty. . . But if the two have incompatible expectations, one will occasionally apply the term to a referent to which the other categorically denies that it applies. Communication is then jeopardized. . . [because] the difference between the two cannot be rationally adjudicated. (317-8)

What Kuhn is getting at here is that whenever we change something that a kind-term refers to, we necessarily change the meaning of the entire kind-term itself. It is not just the part of the
kind-term that refers to the particular that is altered, but rather the entirety of the concept. As soon as the kind-term is redefined by a change in our expectation of a referent, conversation employing different notions of those terms begins to become impossible because the competing notions of the kind-term can no longer be rationally adjudicated.

In order to illustrate the implications of his argument, Kuhn uses the example of water; however, for the purposes of this paper, I want to use “light.” “Light” has certain referents and so long as two people agree about the referents then there is no incommensurability (Figure 1). However, the moment one of the two people begins to have different expectations about what “light” refers to, then the meaning of the whole kind-term changes. For instance, if two scientists both believe that light has a creative function, then there is no incommensurability. However, the moment one of them begins to posit that light does not create nature but instead reveals it, then incommensurability begins to develop on this topic. Although it might appear that there could be overlap between the two versions, this is illusory as the entire meaning of the term has changed in regards to all of its referents. Kuhn’s model is holistic, and terms get meaning in relation to other terms. Whenever one of these terms change, the other terms are necessarily understood in a different way. Take the geocentric/heliocentric example: even though we might still appear to agree about many things regarding the sun in either paradigm, heliocentrist ultimately understand the sun in a completely incompatible way with geocentrists. Even such basic ideas as “it is the orb that gives light” have changed their meanings. Kuhn explains it as, “Calling an item in the overlap region [light₁] induces one set of expectations about it; calling the same item [light₂] induces another, partly incompatible, set. Both names cannot apply” (318). Through differing uses, practitioners have different expectations about the
characteristics and behaviors of certain referents to which they are projecting their language even though they may be using the same word. The result of Kuhn’s explanation is that we are left with the form of Figure 2 rather than Figure 3.

The implication is that practitioners of one kind of science, when arguing from the perspective of their particular paradigm, cannot rationally adjudicate claims surrounding an anomaly when debating with members of the other community. In order to persuade a scientist to another paradigm, Kuhn claims that the persuaded scientist must learn an entire new language thereby becoming bilingual. The implication is that there are some things a scientist can articulate in one language that he cannot in another (324). Effectively, the bilingual scientist has two meanings of “light.” He uses one when he discusses the old science and the other in the new science and never do the two terms meet. The result is that actual cross-paradigm debate grounds to a halt.

Talking Across Paradigms

Incommensurability between paradigms has caused Kuhn to shut off a seemingly viable way to affect a shift in scientific practice. It is in this last move that Kuhn goes too far. In his effort to demonstrate the non-cumulative nature of scientific revolution, Kuhn exaggerates the issue of incommensurability thereby precluding debate as an effective persuasive tool. It may be that eventually there is complete incommensurability between paradigms, but I believe an examination of the actual periods of revolution and their language reveals that one of the key ways practitioners affect change is through debate with the other paradigm. In fact, Francis
Bacon rarely performed experiments; rather, he tried to persuade people to his new science through texts and words.¹ It may be that science ends up with complete paradigm changes, but it does not get there without commensurable dialogue between the competing scientific models. This is a situation Kuhn’s framework does not allow.

And so, while I believe a large part of this framework is correct, I think Kuhn overstates the issue of incommensurability. Although there certainly may be difficulty in talking across paradigms, significant discussion does take place, specifically during periods of revolution. By this, I mean coherent dialogue using kind-terms where some of the referents of that term may be unexpected (in the Kuhnian sense of the word) by one party. To put it in a different manner, I am referring to dialogue where we both “point” to the Earth and mean the sphere that has water, land, and supports life. This area can be rationally adjudicated in either paradigm. However, while I am thinking about these expectations, I simultaneously conceptualize a planet that circles the sun, and you, while maintaining all of the earlier expectations, think about the sphere around which all other heavenly bodies circle. The issue then becomes whether the former expectations (water, land, and supports life) are significant parts of the latter (heliocentrism and geocentrism). Furthermore, if this is the case and they are significant parts, then we must see whether the two paradigms mean exactly the same thing in the area of apparent commensurability or whether a holistic understanding of the terms has caused a shift meaning even when the area appears to remain the same.

In his essay “The Method of Truth in Metaphysics,” Donald Davidson investigates the issue of incommensurability in general and helps us to think about these last two issues. He writes, “those who can understand one another’s speech must share a view of the world, whether or not that view is correct. . . We can make sense of differences all right, but only against a
background of shared belief” (302). Davidson’s claim is that if we understand each other, we necessarily share a view (if not a completely correct one) of the world. Even though our actual beliefs may be different on specific points, the fact that we can articulate them to one another to form a debate is indicative of a largely shared worldview. If we did not agree on many of the terms we use in conversation, then our remarks would be completely unintelligible. In fact, it turns out upon closer inspection that our disagreements might be quite small relative to our areas of agreement because even our ability to disagree still demonstrates the fact that we have many similar ideas about the way that the world operates. For instance, we might disagree over whether the sun revolves around the Earth or the Earth revolves around the sun. However, in order to formulate this dispute we must agree on what it means to revolve. Even more, it is likely that we must largely agree on what we mean by the Earth (the place with water and land where we live) and what we mean by the sun (the orb in the sky that gives us light) in order to talk about what moves around what.

In essence, Davidson gives us a competing framework to think about issues of conversation, disagreement, and debate. Rather than seeing difference as ground for incompatibility, Davidson interprets it as room to reflect on our many areas of commonality. In fact, Davidson’s ideas run parallel to, and dialogue with, my own. During periods of paradigm change, we have large disagreements over the manner in which the world functions. However, once we actually interrogate our views, I believe that we actually agree on, and can rationally adjudicate, many more areas that were necessary for our disagreement. These areas of agreement are the keys to understanding commensurability in times of paradigm change and the subsequent possibility in debate for affecting this change.
However, even though I believe that Davidson is onto a very important idea, we still need to scrutinize his views and empirically establish commensurability before we can move on to the possibilities Davidson holds. I see two possible problems with Davidson’s argument, both similar to the two I presented earlier. The first of these is whether we actually do largely (or at all) agree on the meanings of terms like “Earth” and “Sun.” First, we must decide whether water, land, and people are necessary expectations of Earth within either paradigm. That is to say, we need to decide if these expectations are part of a scientific understanding of Earth. Just because I associate these things with the Earth, it does not follow that they are essential to my understanding of the planet within either paradigm. My claim is that they are. Regardless of the view, the fact that the Earth contains people is paramount to the planet whether we think about it from a geocentric or heliocentric paradigm. And yet, recalling Kuhn from earlier, as soon as some expectations of a kind-term change, our conception of the kind-term as a whole automatically changes with it. Thus, even though we both may think of Earth as the place where humans live, Kuhn would seem to claim that we no longer think of the term human in the same way once we make the switch to a heliocentric paradigm. Our whole understanding of a “human” has changed. Once again, I reject this view. It is possible, in fact feasible, that although part of our understanding of a “human” has changed, there is a large amount about a human that remains the same (we are bipeds endowed with complex linguistic skills regardless of the paradigm).²

The second issue is whether we are actually disagreeing or merely appearing to do so. As with the issue of the Earth and the Sun and agreement, we might only appear to disagree and not really be in dispute. We could simply be talking past each other and interpreting the words one person is using in her paradigmatic schema within our own, very different, incommensurable
view. This is a very real concern, but I believe we can go a long way toward alleviating it by sitting down and spelling out exactly what we mean by the terms of our dialogue. We must think about what it is concerning the Earth that causes us to disagree about it and whether we are talking about the same planet because if there are no common features in our two conceptions of Earth, it would seem that we would have no stake in the planet and thus in the debate as a whole. There would be no reason to disagree. And yet, we do disagree on these issues, often times vehemently (as a case in point, see Galileo and the Church).³

In fact, in an extension of the Davidsonian idea, we can also posit at this point that we may actually agree on concepts that we use different words for, thereby only giving the appearance of conflict. In essence, we need not be using the same term in order to have overlapping expectations of a kind-term. Thus, whenever we sit down and spell out the terms of our dialogue, we might not only find that we have commonalities on terms that are the same (Earth and Sun), but that we are using different words to mean the same thing. In an argument I will explore more fully later on in this paper, Philip Kitcher proposes that, in many instances, the Priestlean notion of phlogiston and the Lavoisiean idea of oxygen actually refer to a lot of the same things. Davidson reminds us that we should not just look for commensurability when we use the same term, but we should see if we are using different words to mean the same thing.

And yet, by stressing the non-cumulative nature of paradigms, Kuhn has required us to forfeit dialogue as a vehicle for persuasion and the necessary commensurability that must accompany it. Therefore, I refuse these specific Kuhnian views and believe that Davidson has the basic framework correct. Davidson places importance on the ways that our general world views are commensurable in many areas. Kuhn, on the other hand, focuses his examination on the apparent incommensurability of paradigms. To return to the previous historical example,
Davidson recognizes that Bolsheviks and Czarists might agree on what our medical needs are in their larger worldviews. However, Kuhn places emphasis in how these same groups would disagree about how these medical needs fit into our specific social needs. Yet, in order to have this disagreement, Davidson would contend that our agreement on the worldview level is essential and that we mean the same things when we talk about what our medical needs are (we need a leg amputated to cure spreading tissue necrosis). When we actually dispute each other’s claims—whether the state should or should not pay for the amputation—the dispute in the paradigm necessarily leans on the overlap in the worldviews. Thus, in Davidson’s view, when we affect paradigm change, there is genuine commensurability between the paradigms in so far as they rely on a shared worldview. I affirm this position. However, I believe a close examination of the writings of the practitioners of different paradigms during revolution reveals that there is an even further level of commensurability: between the paradigms themselves. This is a view I will address later, but for the purposes of the current argument, recognizing Davidson’s level of commensurability is important to understanding, not least of all, the implications of disagreement.

**The Baconian Dialogue**

And so, in order to dialogue coherently, which practitioners of different sciences can do, we must share a common worldview. Moreover, this view holds even when we are disagreeing over topics as large as paradigms (in fact, the disagreement might be a sign of commensurability). In order to explain why I hold these more general views (besides the brief sketches of arguments above) and begin to establish the necessary empirical evidence, I turn to the seventeenth century Scientific Revolution with which I opened. By this century science, or as it was known then, natural philosophy (or scholasticism), had become stagnant. As Peter Dear writes in his study of
the history of science, “The natural philosophy that Francis Bacon and others complained about in the seventeenth century had been effectively defined as a discipline aimed only at understanding the natural world. It was not supposed to be about craft production or the deliberate creation of physical effects” (394). Scholasticism was a university discipline that focused on natural knowledge for its own sake. It sought to understand the world and do little beyond that; the emphasis of scientific knowledge was on the acquisition of knowledge rather than its efficacy in our everyday lives.

Besides the issue of utility, Bacon was upset with the deductive nature of scholasticism. As Richard Foster Jones writes in his introduction to a collection of Bacon’s work:

Another hindrance to the increase of knowledge in Bacon’s eyes was syllogistic logic, which Aristotle had established, and which the Aristotelians for the most part religiously followed. The efficacy of this logic depends in large part upon the truth of the major premise, and . . . these premises were general principles received on authority of the ancients or hastily devised from a few random particulars” (xvii-i).

The problem with this kind of process is readily apparent: if our major premise is untrue, then the rest of the knowledge that follows from it will also be false. For instance, Jones points to the Aristotelian idea that nature does nothing in vain (xviii). We now know that this premise is false on many levels (attributing sentience to nature, neglecting its random aspect), and it follows that deductions from this premise are also false. Even more, if we form a premise from only a few particulars, we risk mis-forming that premise. For example, if we have seen only black bears and therefore conclude that all bears are black, we miss white and brown bears, not to mention spectacled and panda bears. Bacon wants us to discard the syllogistic methodology, the unquestioning reception of received truths, and the hasty investigation of nature.

And so, Francis Bacon worked to change this understanding of natural philosophy. He wanted to create an inductive science that had room for both pure science and utility—or, as he
called it, experiments of Light and Fruit. Furthermore, Peter Dear believes Bacon affected this change by “attemp[ing] to represent natural philosophy, quite against its usual academic Aristotelian grain, as necessarily having a practical or utilitarian dimension. . . He began by taking the scholastic notion of analysis and synthesis . . . and explicated it in relation to natural philosophy in . . . such a way as to imply that ‘effects’ or phenomena were tantamount to practical uses of natural philosophy’s explanatory principles” (395). Bacon worked to bring about his change by specifically going after the notion that science was not to have practical uses. In order to do this, he wanted to conflate two previously separate notions. He wanted to demonstrate how knowing nature was the same as being able to use nature.

Now, the import of Dear’s theory lies in the manner in which Bacon went about conflating these two areas. Dear explains how Bacon took a scholastic concept and then “re-explained” it in a way that was consistent with his new notion of science. Bacon embraced concepts people were wholly familiar with, like analysis and synthesis, and retained a large part of those concepts. He did not change the basic notion that there are some things we know a posteriori (natural phenomena) and some that exist a priori (laws or theories). This framework remained intact. What Bacon did do, according to Dear, was to alter some parts of what these scholastic concepts pointed to. No longer were they to be used for knowledge for its own sake, but they could be manipulated in order to produce useful works (Figure 4).

When I put Dear’s ideas in Kuhn’s terms, Dear is talking about two kind-terms within a community’s lexicon: natural philosophy (Science$_1$) and Baconian induction (Science$_2$). Both of
these terms are learned through use, have projectible referents, and are defined by the practitioner’s expectations. Dear’s claim in Kuhn’s terms is that practitioners of either science have certain expectations about the referents (the components) of their science. Some of these expectations are the same regardless of the scientific paradigm. They do not just appear to be similar, but they are exactly the same. The two kind-terms get their different meanings from expectations that are outside this area of commonality (knowledge for itself and utility, as in Figure 4). It seems as though Dear is claiming that Bacon worked to create commensurability between paradigms not just on the worldview level, but on the paradigmatic level as well. That is, the practitioners of both sciences would be able to rationally adjudicate the expectations of analysis and synthesis within the models of their paradigms. This assertion flies in the face of Kuhn’s claims as Dear wants us to believe that there are areas of commensurability even within the paradigms in periods of scientific revolution.

If we return to Jones’ comments on the nature of the syllogism, we have another argument against Kuhn’s ideas. Jones claims that Bacon was skeptical of both the inductive process and the way that we formed the major premises of that process. However, what Bacon does not do is reject the idea that we should get rid of reason and examination of particulars altogether. As Jones writes, “syllogistic logic represented to Bacon the unlawful exercise of reason divorced from materiality. Again and again he [under]scores the proneness to rely too much on reason, and insists that the latter should be constantly tied to facts” (xviii). Bacon wants to reorient scientific practice, not necessarily alter it entirely. He believes the scholastics are onto something when they examine a few particulars, but Bacon believes that they need to be more rigorous in their examination. Furthermore, the examinations ought to be minor premises building to a major one, not the other way around. Moreover, Bacon still believes in the power
of reason; it is just that scholastics place too much emphasis on it. The result of Jones’ argument is something like Figure 5.

Now, both Dear and Jones’ ideas run parallel to my own. All of us work to demonstrate the validity of Davidson’s claims by demonstrating areas of rationally adjudicable commensurability during periods of scientific revolution. Moreover, we are speaking specifically of those periods of revolution and the ways that the practitioners worked to affect change through debate (since Bacon did not perform experiments, see Jones xiv); we are not referring to the later practices of that science. While we differ in the scope of our arguments—I will analyze Bacon’s actual language—all of us agree that by retaining a common framework, Bacon was, in a sense, providing that common ground for disagreement. He was keeping some things in common in order to provoke a meaningful conversation. Even more, by retaining areas of commensurability, Bacon provided a structure from which he could build more and more commonalities, perhaps ending in complete paradigm change. By retaining the ideas of analysis and synthesis, reason and examination, Bacon left himself open to dialogue with the other paradigm.

**The Common Ground of Light**

While the previous discussion allowed us to look at areas of commensurability on a large scale, I want to size the investigation down a notch for perhaps a more nuanced investigation of empirical evidence for commensurability in paradigm change. Examining the actual language of scholasticism allows the reader to see exactly how Bacon went about retaining these areas of commensurability. It is here in making new law and theory, along with the demonstrations of
application and instrumentation, that philosophers made their arguments for and against different paradigms. Within the words we find the Davidsonian areas of commonality that allow for later paradigm change. Furthermore, this close reading can also serve as a base to interrogate Kuhn’s claim that revolutions occur through demonstration, not debate.

In fact, in the seventeenth century, Francis Bacon worked to change the prevailing natural philosophy mostly through the medium of words. As Peter Pesic tells us, “Francis Bacon played an important part [in the emergence of modern science] not so much because he himself performed significant experiments but because he envisioned the emergent character of experimentation. Bacon described himself as a trumpeter (bucinator) or herald rather than as a combatant” (81). Thus, Bacon’s import to the history of science is not so much for what he did, but what he said. He explained his new science through words, trumpeting its cause, rather than by actually wielding his science in experimentation. And yet, Bacon is commonly held to be the father of modern science, a fact that might seem impossible in Kuhn’s schema. However, if we accept Dear and Jones’ arguments and Davidson’s belief, then there is room for Bacon to affect this kind of shift through words. In fact, this section seeks to demonstrate how Bacon might have accomplished such a feat. Even though Bacon was largely an “armchair” scientist, he still led the charge for an entirely new science.

As Bacon worked to change philosophic practice, he had to write against and with a vast tradition. One of the most prominent thinkers of the previous age was the scholastic philosopher Robert Grosseteste. One of Grosseteste’s more well-known tracts is entitled “On Light,” in which Grosseteste writes:

The first corporeal form is, in the opinion of the philosophers, more exalted and of a nobler and more excellent essence than all the forms that come after it. It bears, also, a closer resemblance to the forms that exist apart from matter. But light is more exalted and of a nobler and more
excellent essence than all corporeal things. It has, moreover, greater similarity than all bodies to the forms that exist apart from matter, namely, the intelligences. Light therefore is the first corporeal form. (“On Light”)

The fact that the scholastic philosopher believes that light is the first corporeal form has several implications for light. The first of these is that it is “more exalted and nobler” than all the forms that come after it (meaning all other corporeal things since light is the first). The reason light is nobler is because it has greater similarity to “the forms that exist apart from matter.” Grosseteste calls these things the intelligences, but their import is that they are incorporeal; they are apart from matter, and light becomes exalted through its closeness to them. Even more, light is second to the incorporeal as all other forms come after it.

Grosseteste also makes it clear that just because he is labeling light corporeal, it does not follow that light is material. He writes, “the extension of matter in three dimensions is a necessary concomitant of corporeity, and this despite the fact that both corporeity and matter are in themselves simple substances lacking all dimensions” (“On Light”). Thus, light itself is immaterial because its corporeal nature makes it part of this world (it spreads out), but it inhabits the world in an immaterial nature (it has no mass). Only by extending itself infinitely in all directions does light endow the universe with the mass necessary for materiality. According to Grosseteste, light is close to the incorporeal, but light itself is corporeal while being immaterial.

Francis Bacon works to retain certain expectations with Grosseteste’s idea. In the introduction to his *Magna Instauratio*, Bacon writes, “the divine procedure, which in its first day’s work created light only and assigned it to one entire day, on which day it produced no material work, but proceeded to that on the days following” (247). Bacon believes light, and light only, was created on the first day. Since it alone was created first by the divine procedure, Bacon suggests that light is more exalted than other things of this world. Also, Bacon makes it
clear that through this closeness, light follows second from the incorporeal. Furthermore, Bacon, like Grosseteste, believes that light is immaterial. Bacon writes that “no material work” was produced on the first day, but that it would follow. This is not just extremely similar to Grosseteste’s notion that immaterial light existed first and then the world proceeded from it, but rather the two thinkers have an area of commensurability. When speaking of light, both men employ some of the same expectations. They both see light as the first thing created, and as such it is nobler, being closest to the incorporeal. Even more, both men view light as completely immaterial. Lastly, both thinkers see the material world as subsequent to light. Regardless of the paradigm, these points are the same. Whenever either man said “light” in a scientific sense, he used it expecting his interlocutor to understand these referents. The writers placed these components as characteristic of light within their own paradigmatic frameworks, and the result is that these expectations could be rationally adjudicated, not just talked about, in either paradigm.

The next step is then to see how Grosseteste and Bacon also expect the reader to assign other referents to “light” while maintaining agreement on the previously rationally adjudicated areas. Immediately following his comments on light being the first corporeal form, Grosseteste writes:

Thus light, which is the first form created in first matter, multiplied itself by its very nature an infinite number of times on all sides and spread itself out uniformly in every direction. In this way it proceeded in the beginning of time to extend matter which it could not leave behind, by drawing it out along with itself into a mass the size of the material universe. (“On Light”)

For Grosseteste, light operates in a very physical way. Light works to extend matter and through this extension to create the physical universe. It is specifically able to perform this function because of its relation to the incorporeal. The connector “thus” entails that this second passage is somehow conclusive of the first one, and since the first statement established light’s preeminence
with the incorporeal, it is reasonable to conclude that it is because of this connection that light is
able to create the universe through extension. The takeaway implication from Grosseteste’s
statements is that the author uses light’s special and exalted association with the incorporeal to
explain how light plays a physical role in the structure of the universe. Whenever Grosseteste
uses light, he wants to add to the previous referents. He expects the reader to also assign the idea
of light creating matter through extension as a referent of light.

It is important to understand here that Grosseteste is not speaking metaphorically; he
literally believes that light has a creative function. As Simon Oliver explains in his analysis of
Grosseteste’s “On Light,” “Grosseteste [concludes] light is the first bodily form, which some call
corporeity; it necessarily accompanies and enables the diffusion of matter into three
dimensions. . . [More,] light must be multiplied an infinity of times in order to extend matter and
produce a finite corporeal universe” (Oliver 156). Oliver understands Grosseteste to literally
mean that light, as it multiplies itself, “enables,” “extends,” and “produces” a universe that
consists of “three dimensions” and is “corporeal.” When Grosseteste speaks of light having a
creative power within his natural philosophic paradigm, Grosseteste does, in fact, mean this
assertion literally.

However, where Grosseteste used light’s primary, exalted, immaterial nature and added
an explanation of the creation of the physical universe, Bacon wants to use light in order to
explain how the universe is revealed, not created. In the introduction to the Magna Instauratio,
he writes, “O Father, who gavest the visible light as the first fruits of creation, and didst breathe
into the face of man the intellectual light as the crown and consummation thereof, guard and
protect this work” (264-5). Bacon sees two distinct kinds of light: the visible and the intellectual.
It appears that when Bacon mentions the first kind of light, he has something physical in mind: it
reveals creation, or the visible, material world. However, when he mentions the intellectual light he is talking more metaphorically, referring to our mental processes. The implication is that we begin to learn by examining creation with the visible light and then intellectual light, as “the crown and consummation,” completes the process.

In fact, Bacon confirms these implications later in the same text. He writes, “For I admit nothing but on the faith of the eyes” (261). Bacon flatly tells the reader that the way that he “admits” things, the way that he learns things, is by using his eyes to observe. Combined with the previous passage, the reader begins to understand the function of light in Baconian science. Bacon tells us that he admits nothing but on the faith of the eyes and also that light was the first fruits of creation; it is the way the material world is revealed. Thus, light’s function in Bacon’s schema is not a creative one. It does not extend itself infinitely in all directions and so create matter. What it does do is reveal for the eye the facts of the natural world. Bacon effectively removes some of Grosseteste’s expectations and adds his own. However, Bacon does not remove all of the scholastic ideas about light. In Bacon’s world light is literally still close to the incorporeal and thus is exalted: a real God really did create light and only light on the first day. Even more, Bacon’s idea of light, like Grosseteste’s, is that it is immaterial. When Bacon says “light” he is still invoking some of the same expectations as Grosseteste; the two men share some expectations that can be rationally adjudicated. There is complete commensurability on these points. However, both men also expect practitioners of their respective paradigms to assign different characteristics to the referents. Grosseteste sees light as creating while Bacon sees it as revealing (Figure 6).
Now, as with Grosseteste, it is important to see whether Bacon is speaking literally or metaphorically on these points. As Steven Pinker reminds us in his book *The Stuff of Thought*, “many scientific theories were first stated as analogies, and often are still best explained that way. . . Metaphor in science . . . is a version of the everyday process in which a metaphor is pressed into service to fill gaps in a language’s vocabulary” (254, 257). It should not surprise us to see either man, Grosseteste or Bacon, employ “light” metaphorically because it is a common enough thing to do in science, especially in the explanatory phase. However, we have already established that Grosseteste was speaking in a literal manner, and Bacon appears to be doing the same. Although his work is fraught with tropes of light, they are all predicated on the fact that he means the above quotations literally. For instance, in the *Magna Instauratio*, Bacon talks of dragging things into the light that the “false” (scholastic) science never would have thought to look after (261). Bacon wants to drag these things into the light because light reveals objects to the eyes, it does not create those objects; they existed before and had to be dragged. Again, in the fifty-sixth aphorism of the *Novum Organon*, Bacon claims that truth is not found in the felicity of any age but in the light of nature and experiment. He makes it clear that truth is found, is revealed, in the light of nature; it is not created by that light.

Thus, even though Bacon might trope light, he is only able to do so because light reveals, and in his paradigm, light reveals, in part, because it is literally the exalted, immaterial mechanism that is close to the incorporeal (God). As Philip Kitcher reminds us, “seventeenth century thinkers such as [Robert] Boyle and Bacon attributed special significance to this project [the new inductive science] because, seeing nature as God’s Creation, to expose the structure of nature was to recognize the divine intentions” (94). As Bacon was a Christian theist, it is reasonable to posit that he believed God literally created light first. From this first creation of the
immaterial light, God created the rest of the world that this same light reveals. The later
metaphor in Baconian science is therefore predicated on the literal commensurability illustrated
in Figure 6.

Returning to the literal relation between Grosseteste and Bacon, because these last
expectations (creation versus revelation) cannot be rationally adjudicated, Kuhn wants to believe
that there is full incommensurability between the paradigms. Nevertheless, this is not the case.
Some referents of “light” are the same and can be rationally adjudicated. They are essential
terms to how each man develops his concept of light, and they are exactly the same. As such,
there are points of commensurability even amongst kind-terms in different paradigms. I affirm
that different paradigms may use the same word and intend the same referents. Shifts to a new
paradigm do not involve learning an entirely new language. Rather, people may simply possess
a monolinguisum and work to understand new referents to what is in many ways still the same
word. In Bacon’s case, he maintains some of the scholastic meanings of light while
simultaneously introducing new referents.

The Cases of Galileo, Priestley, and Lavoisier

The Baconian idea of light provides a striking example of how Kuhn’s notion of
incommensurability (used to demonstrate the non-cumulative nature of revolution) obscures the
commensurability in the actual periods of paradigm shift. However, other thinkers are also
elucidating similar examples of ways in which Kuhn’s notion of incommensurability hides the
manner in which debate may affect paradigm change although they may not state it in such a
fashion. In his essay, “Galileo’s Experimental Discourse,” R. H. Naylor examines the apparent
gulf between Galileo’s early and mature work. Specifically, Naylor wants to look at the way
Galileo’s attitude toward experimentation changes through the body of his work.
Naylor spends the majority of the essay tracing the different ways in which Galileo’s attitudes toward experimentation changed. In the beginning, experimentation played a negating role for Galileo. Naylor writes, “Experience and, on occasions, experiments are employed as part of a rhetorical repertoire aimed to refute Aristotelian physics. . . However, experimentation does not by any means play a positive confirmatory role able to establish the claims of Galileo’s theory; on the contrary, it proves incapable of corroboration” (117-8). Thus, Galileo set out to change the Aristotelian notion of physics which seemed inadequate. However, when Galileo tried to use experimentation to do this, it could not yield positive results. In a sense, experimentation could only refute ideas; it does not create any on its own, it could not be a guide to action (Naylor 118).

Unable to use experience in a positive sense, Galileo could not use it to explain motion, the primary subject of his inquiries. As Naylor tells us, “Galileo at first, in De Motu [one of his earlier works], rejected Aristotle’s theory but regained the cosmological explanation of motion in terms of place. . . In De Motu Galileo claimed not only to have found the correct mathematical form of motion but to know its ultimate cause” (132). Galileo set out to use experience to disprove Aristotle but could not do so and thus had to regain a cosmology of nature in terms of ultimate causes. In a sense, Galileo affected a slight break from the past, but it was nothing revolutionary. The scientist had simply replaced one cosmology for another. True, Galileo produced a mathematical formula for motion, but he was only able to do so because of an account of motion’s ultimate cause; experimentation was unable to provide such an answer. Science was still predicated on cosmologies, only now a different man was offering the totalizing explanation.
However, Naylor notes a dramatic shift by the time Galileo pens the *Two New Sciences* near the end of his life. Naylor writes:

In the *Two New Sciences* Galileo was left only with the former [mathematical explanation, not with the latter, ultimate causes]. He had no explanation of why bodies fell: this had become an inexplicable feature of the world. Thus there is a complete reversal of value. For Aristotelians it was cause that was paramount while form played an entirely secondary role. Form was really beneath consideration... Galileo’s position was the polar opposite. It was cause (in the Aristotelian sense of Final Cause) that could be left aside but on the contrary the precise form of motion was of overriding significance. (132-3)

Galileo has rejected his earlier idea of a cosmology of final causes. By the end of his career, Galileo was constructing experimental proofs for various natural phenomena. These proofs revealed the ambiguity of nature (Naylor 130) and so Galileo could no longer produce a totalizing explanation of the world. Since he is unable to produce a cosmology, Galileo can no longer value Final Causes as the Aristotelians do; they are completely insufficient for describing nature. What he could do was produce explanations based upon the performance of individual phenomena (or forms). This revaluation of nature produces the reversal of emphasis that Naylor examined. The forms are important, not the Final Causes.

And so, in Kuhn’s view, the scholastic idea of Final Causes is no longer able to account for the apparent variability of nature. Too many anomalies have arisen, and so Galileo set out to find a better explanation. In finding this explanation, Galileo rejects the scholastic worldview and posits his own based on the notion that experimentation leads to truths (even though he never fully articulated such a science in the manner Bacon did). This shift represents a revolutionary break from the past as Galileo’s worldview is incommensurable with that of the Aristotelians; it is a completely new science.
However, this kind of an account misses the ways in which Galileo’s description of science, according to Naylor, retained many Aristotelian notions. Naylor argues that Galileo’s science was a reversal of value, not idea. Galileo still completely understood and, more importantly, employed the scholastic ideas of cause and form. They were integral for understanding his worldview. The break actually occurred in the valuations of the terms, not the terms themselves. Similar to the manner in which Dear argues that Bacon retained scholastic notions of analysis and synthesis while simultaneously reordering the focus of science, Naylor claims that Galileo retained the scholastic notions of form and cause while simultaneously reordering the value of those terms (see Figure 7).

Even though Naylor may not have intended it to be such, his analysis of Galileo represents a striking example of the inadequacy of Kuhn’s incommensurability. Even though we may posit that eventually the scholastic and Galilean ideas of science became incommensurable, at the moment of revolution, there were areas of rationally adjudicable commonality between the two groups. Practitioners of either science could judge how causes and forms fit into either paradigm. However, they could not adjudicate the different evaluations of those same terms.

Similar to Naylor’s study of Aristotle, Philip Kitcher’s examination of the Chemical Revolution in the Eighteenth century provides another instance in which commensurability can exist across paradigms. However, rather than finding commensurability in scientific practice (as Dear did) or in particular terminology (as I did) or in general terminology (as Naylor did), Kitcher finds commensurability in ideas. In his book, The Advancement of Science, Kitcher spends time analyzing the phlogiston theory of Priestley and the oxygenation theory of Lavoisier.
As Kitcher writes, “There is a very simple story about the chemical revolution of the eighteenth century. Priestley, so the story goes, employed a language containing terms—‘phlogiston,’ ‘principle’—that fail to refer [to what we observe in nature]. Lavoisier used a language containing expressions—‘oxygen,’ ‘element’—that refer to kinds that Priestley could not have identified” (97). The idea is that Priestley had one way to talk about nature (combustion emits phlogiston) that proved entirely inadequate in discussing what was actually happening. Lavoisier then came along and proposed an entirely new way of understanding the process of combustion (chemical reactions involving oxygen) that not only was a much more satisfactory account than Priestley’s, but was also completely incompatible with Priestley’s phlogistonian paradigm. Kitcher, however, wants to complicate this idea.

Kitcher goes about this complication by noting the “heterogeneous” reference potential of scientific terms. As he writes, “Our problems . . . arise from the presupposition that there should be a uniform mode of reference for all tokens of a single type. Once we liberate ourselves from this presupposition, adopting the notion . . . that a scientific term (type) may have heterogeneous reference potential, we can begin to make sense of the language of phlogiston theory” (101).

What Kitcher is getting at is that words, specifically scientific words, do not have a one-to-one correspondence with their referents; one word does not equal one referent. Language does not operate in such a clean, neat way, not even that of science. Instead, Kitcher claims, one term may have several referents. These referents may be interrelated, although Kitcher never signals that they have to be.

Kitcher believes that this heterogeny is especially true of theory-laden terms. What he means is that “theory-laden terms have heterogeneous reference potentials [because] the theoretical hypotheses with which they are laden are claims that are, in conjunction, equivalent to
the assertion that all the modes of reference fix reference to the same entity” (103). What Kitcher means is that theories have answers to many hypotheses, and the answers to all these hypotheses are what make up the theory. Whenever we assert an answer to a hypothesis, we necessarily attach that answer to the theory. Because theories are so large, there are many different kinds of possible referents for that theory. For his examination, Kitcher has “dephlogisticated air” specifically in mind.

Kitcher then begins his analysis of Priestley’s language of dephlogisticated air. He concludes that, “Inside his [Priestley’s] misbegotten and inadequate language are some important new truths about chemical reactions, trying to get out. A false presupposition, the idea that something is emitted in combustion, infects most of the terminology. The natural approach to Priestley’s language is to take the faulty central idea . . . as fixing the reference of phlogiston” (99). However, we have just examined how it is false to assume such a theory-laden term as phlogiston has only one referent, here that of emission. Surely that is a part of the idea of phlogiston, but it in no way constitutes all of the term. Therefore, when we speak of dephlogisticated air, it is the air when phlogiston is removed, yes, but it may also refer to other things.

And so, after an analysis of several of Priestly’s experimental reports (100, 102), Kitcher concludes that what Priestley is describing also sounds a lot like oxygenated air. In these passages, Priestley does not speak about what was removed from the air—the lack of phlogiston—but rather he talks about what was gained from the process—the quality of the new, dephlogisticated air, in other words oxygen. This analysis allows Kitcher to conclude, “Because the referents of the tokens of ‘dephlogisticated air’ are fixed differently on these occasions, Priestley and Cavendish [a similar scientist] enunciate important new truths” (102). In a sense,
since the referents of “dephlogisticated air” are not fixed, the term may refer to more than one thing; it may be the product of more than one hypothesis in the phlogistonian paradigm. In this case, the hypothesis described what was left when the air became dephlogisticated, and the answer was a description nearly identical to a Lavoisiean conception of oxygen. It appears, then, that when scientists from different paradigms used completely different words, these words actually shared some of the same referents. There was an area of commensurability even though different terms were being employed.

Kitcher then uses this examination to attack Kuhn’s notion that scientific revolutions are non-cumulative. Kitcher wants to show that science can make progress and so proposes that “We could offer a reference-preserving translation of [Priestley’s] texts. . . [This] motivates a general thesis about conceptual change in science. Conceptual change is change in reference potential” (103). Notice that Kitcher wants to use “conceptual change” instead of “paradigmatic change.” This is because he wants to persuade us that science can build on itself—it can be cumulative—because we can preserve some of the referents of a science into the concept of the next science. However, I think Kitcher betrays himself whenever he uses the term “translation.” Kuhn has established that he believes that scientists can be bilingual during periods of revolutions. They could certainly translate words from one scientific paradigm into another so that the scientists could understand each other (as Kitcher says Lavoisier could “understand” Priestley [103]). As long as Kitcher relies on the idea of translation, I do not think he causes Kuhn to forfeit anything. As long as terms must be translated from one scientific terminology to another, then the option of incommensurability, and thus paradigm change, remains in play. To use the historical example, surely a Czarist could understand a Bolshevik’s claim for state funded amputation; however, it does not follow that it is a claim that can be rationally adjudicated
between the paradigms. Again, a geocentrist could understand what it would mean for the sun to revolve around the earth, but it does not follow that he could adjudicate the claim.

What Kitcher should say, I believe, is that the descriptions of dephlogisticated air and oxygenated air represent an area of actual commensurability. This is so, not because we can translate referents, but because when we say those terms we actually share certain expectations. When Priestley says “dephlogisticated air” he means both air free from phlogiston and air in which mice and humans can live (see Kitcher 100). Similarly, when Lavoisier says “oxygenated air” he does not just mean air with the element oxygen in it, but also air in which mice and humans can live (see Figure 8).

Although both men are using different kind-terms, they still share expectations. Whenever either man spoke that word in his paradigm, he expected his listener to apply referents that were rationally adjudicable with referents from the other paradigm. In this regard, Kitcher’s argument is similar to Dear’s. Both men are talking about terms that are different in the different paradigms but share common expectations. However, his argument is closer to mine in that we are examining actual terms. The strength in Kitcher’s argument is that he demonstrates that commensurability is possible not just in basic kind-terms (“light”) or on the level of different sciences (Naylor, Dear, and Jones), but that it is possible with kind-terms that are heavily theory-laden. Even though Kitcher does not quite see the possibility in his argument, I think that this interpretation of his work is not something he would reject.
Paradigm Change through Debate

And so, the implication of all these different arguments, Dear’s, Jones’, mine, Naylor’s, and Kitcher’s, is that debate between paradigms is possible. We have all demonstrated how there is rationally adjudicable, commensurable ground between competing scientific practices. The result is that all of these thinkers have provided a linguistic base from which we can begin to conceptualize how paradigm change might occur through debate as much as through demonstration. The task now is to propose a theory for how paradigm change might occur through the process of debate.

To return the discussion to the Davidsonian language and the Baconian example, if not the broad Davidsonian argument, Bacon demonstrates how, in their areas of paradigmatic disagreement, he and Grosseteste actually agree on many different expectations of the kind term: that light is close to the incorporeal, that light is exalted through this relationship, and that light is immaterial. In fact, Davidson would say that these areas would have to be rationally adjudicable for the two scientists to even have the disagreement to begin with. However, that being said, they did have areas within their paradigms that were not rationally adjudicable, and this is what formed the disagreement. Yet, what this set up gives Bacon is a foundation from which he can establish commonalities in order to persuade a natural philosopher over to the new science. By actually instituting the kind of commensurability Davidson anticipated, Bacon begins the process of persuasion to a new paradigm via debate.

We know the effects of this debate fairly clearly from Kuhn’s earlier argument: different expectations—which result in different definitions—give us different projectibility. That is to say, if I expect light to reveal the world instead of create it, when I project the kind-term light onto different referents, I will only do so to referents that share this characteristic. Referents that
appeared to be constructing the universe rather than revealing it would be discarded as not being
light. Thus, when we redefine a word, give it different expectations, we necessarily change the
way we project that word onto referents in the natural world.

However, the question of how we get to the point where we change the expectations and
so redefine the kind-term remains unsolved. Yet, by maintaining commensurability with the old
paradigm, Bacon gives us a chance to theorize how this shift might take place. In a sense, the
common expectations give us the first, accepted premise to an argument. From this first premise,
we can project our expectations of the kind-term in different ways. Where the effects of debate
occur by different expectations causing different projectibility, Bacon now seems to be working
in the opposite manner. If “if a, then b” is true, then while the converse is not logically true, it
certainly still holds that it might be true in different manners that are not primarily logical in
nature. All of this is to say that it could be very possible that we can affect a change in
expectations by changing the projectibility of a kind-term, something Bacon’s commensurability
allows us to do. In a sense, different projectibility, specifically different projectibility as
established through debate, can lure practitioners to different expectations.

Earlier in this paper, I described how Kitcher proposed that theory-laden words did not
have a one-to-one correspondence because of the variability of their hypothetical content. Now I
want to take his idea one step further and turn to Quine in order to think about how language as a
whole does not work on a one-to-one basis. In his essay, “Two Dogmas of Empiricism,” Quine
states, “The totality of our so-called knowledge or beliefs . . . is a man-made fabric which
impinges on experience only along the edges. Or, to change the figure, total science is like a
field of force whose boundary conditions are experience. A conflict with experience at the
periphery occasions readjustments with the interior of the field” (269). Quine believes that all of
our knowledge, in whatever way we know it or store it, is like a force field. For him, no part of
our knowledge exists as a one-to-one correspondence. Rather, each bit of knowledge is
connected to many other pieces of knowledge and these other pieces of knowledge are connected
to still more and so on and so forth until we construct the totality of our field of knowledge. The
implication here is that whenever we change or readjust one piece of knowledge, we necessary
affect, and perhaps change, many other pieces. When we change one thing, it has the possibility
to reverberate throughout the field and affect change to many different areas of our belief system.

Next, we need to puzzle out what Quine means by experience. Certainly, to some degree,
he intends actual, lived experience. In this understanding, whenever Quine talks about
experience adjusting the rest of the field, he means that the way we inhabit the world can change
our store of knowledge. This understanding fits comfortably with Kuhn’s notion of paradigm
change. We understand nature in one way, but whenever certain anomalies creep up—
experience at this edges—we begin to adjust the whole of our knowledge. Even more, whenever
someone tries to persuade us to a new paradigm by demonstrations, they are changing our
experience at the edge of the field. Quine’s idea helps to explain how Kuhn’s notion of
paradigm shift takes place.

However, Quine does not simply mean lived experience as his only understanding of
“experience.” In his essay, Quine attacks the idea that there is a division between analytic truths
(those whose truth-value exists independently of matters-of-fact) and synthetic truths (those
whose truth-value depends upon matters-of-fact). Quine attempts to define what an analytic
truth might be, but ultimately ends up failing. This forces him to conclude, “It is obvious that
truth in general depends on both language and extra-linguistic fact” (266). The products of our
field of knowledge, our truths, consist of both our lived experience outside of dialogue and
language. Another way to phrase it might be: our field of knowledge depends upon our interactions with the world in all manners and the semantical structure of language.

Notice here that Quine in no way precludes language as being part of our interaction with the world. In fact, it makes sense that part of our experience would be the manner in which we dialogue with other people. However, Quine goes on to note that even the semantical structure is dependent upon our experience. He writes, “The statement ‘Brutus killed Caesar’ would be false if the world had been different in certain ways, but it would also be false if the word ‘killed’ happened rather to have the sense of ‘begat’” (266). Quine is suggesting that all of language is dependent upon experience; there is no *a priori* component to it. “Kill” means “the act of ending a life” and not “begat” because we assigned that meaning to that sound. It is through our interaction with the world that we learn and assign definitions to words. The implication is that even language is wholly dependent upon experience.

Thus, whenever Quine speaks about experience at the edges of the field, he is not just talking about how we inhabit the world, but also about the way we talk. In fact, even though experience only exists at the edges, because truth is dependent upon language and extra-linguistic fact, and language is entirely composed of experience, it follows that all of our knowledge is the product of some experience, be it through dialogue or demonstration. It follows, then, that just as much as demonstration may be able to affect a shift in our knowledge store, dialogue, as a form of experience, can do the exact same thing.

However, for this process to happen, for dialogue to change the truth-value of one part of our field of knowledge and so reverberate throughout the whole of the field, we needed an area of commensurability for that dialogue to take place. With the various analyses of scientific texts and understandings in this paper, I have demonstrated that, contrary to Kuhn, an area of
rationally adjudicable, commensurable dialogue does exist. From this point of commonality, the burden is now upon the various interlocutors to persuade practitioners of one paradigm over to a new one. Their task is to argue how different projectibilities of kind-terms are both feasible and satisfactory. Once the interlocutor accepts a second premise from the first, then, since knowledge is not a one-to-one correspondence, there is the possibility that this one change could affect other truth-values (or kind-terms) within the interlocutor’s knowledge and so reverberate throughout its entirety. By accepting enough different projectibilities for a kind-term, the interlocutor could change the expectation of that kind-term which is then a change in meaning. A change in meaning gives us a new definition within a new paradigm. This kind of a process allows for paradigm change through the medium of debate.

To return to the Baconian example, both Baconists and scholastics believe that light is noble, close to the incorporeal, and immaterial. This is the area of commonality between the fields of knowledge where both groups of thinkers have these same, rationally adjudicable expectations; they project that referents will have these characteristics. The task of the Baconian scientist is to add a projection to this list. Specifically, the Baconist wants to convince the scholastic that light reveals the world to the observer. All rhetorical and persuasive tools are in play here: tropes (recall Pinker), appeals to authority, presentation of evidence (within the argument, as opposed to a pure demonstration), and others. For instance, let’s take the common expectation that light is close to the incorporeal; this point is not in dispute. In Grosseteste, the incorporeal is the intelligences; however, in Bacon, the incorporeal is God. Bacon can then make an appeal to the religiosity of the scholastic. By reassigning the incorporeal as God instead of an ambiguous term like the “intelligences,” there is a chance that this change in knowledge will reverberate throughout the truth field. For instance, if the scholastic accepts that God is the
incorporeal, then it seems reasonable he would believe that God created light, and only light, on the first day. From this point, it would seem highly possible that the scholastic could be persuaded to accept the rest of the creation story. Once the scholastic accepts this story, then he begins to realize that light did not create the universe, but God did. By changing the projectibility of the kind-term, Bacon has worked to strip away an expectation. By definition, a change in expectation engenders a change in meaning. Bacon must now continue this process he has started in order to completely redefine the kind-term and convince the scholastic that light reveals the nature that is God’s creation.

Referring back to Quine, this process that began on a small scale within a single kind-term in one person’s lexicon can then continue to reverberate on a larger and larger scale. Once Bacon convinces a scholastic to redefine light as a revealing entity, then Bacon can begin to expound upon how we observe that which light reveals. Through this observation, Bacon can posit, we experiment in order to more carefully determine the features of that which we observe. Once we determine the features, then we can begin to acquire particular knowledge. Enough particular knowledge and we can form generalized rules about the behavior of nature. While only an extremely brief sketch, this example provides an illustration about how the redefinition of one kind-term, through argument, could affect a whole paradigm shift. Even more, while this sketch relied mostly on a kind of one-to-one illustration (as it is the simplest to create and follow), Quine reminds the reader that the track to change need not proceed in such a direct path; it can occur in many different directions and ways.

Now, I need not posit that paradigm shift occurs only through debate; that is not my object. I see no reason to suppose that debate and demonstration could not work in concert. In fact, I think that this is the most likely scenario. However, what Kuhn does is preclude the
possibility of change through debate because of the manner in which he seeks to describe the non-cumulative nature of paradigm change. I believe that this is not the case: that we can affect scientific revolutions through verbal argumentation. A close reading of Francis Bacon and an examination of Galileo and Priestley reveals that there is commensurability between paradigms, something Donald Davidson predicted when he noted that disagreements are often signs of commonality. From this area of commonality, we can begin to assign new projectibility to kind-terms and so lure our interlocutor over to a different series of expectations, and thus a new definition, of the kind-term. Quine reminds us that each time we make a new definition, each time we alter our field of knowledge, we can change the entirety of our truth field. Eventually, we are able to persuade our interlocutor over to a completely new understanding of the original term, an understanding that is still rationally adjudicable with certain expectations of the old term.

It may be that the two paradigms, and thus the two kind-terms, eventually grow incommensurable. This is a possibility as science grows and develops. In fact, it may be that revolutions are non-cumulative. However, neither of these suppositions should cause us to obscure what is actually going on during the periods of revolution. And what is going on is that practitioners of different paradigms are attempting to persuade their interlocutors to a different paradigm through demonstration and debate. This fact holds for the Scientific Revolution with which this paper opened, and it is possible for revolutions in general.
Notes

1 This is a topic I will take up presently.
2 I am not committed to arguing these points as they specifically relate to geocentric and heliocentric paradigms. What I have done is give plausible rebuttals to arguments against Davidson. I suggest that these backgrounding examples are sufficient for preliminarily thinking about how Kuhn’s claims could be false. If the reader requires further persuasion on these points, I refer her to Dear’s arguments on the Scientific Revolution and my own arguments on light in order to think about how my claims about geocentrism and heliocentrism could actually be the case. The example of light is what is really at issue and provides an instance where Kuhn could be wrong. This then opens up other cases that could follow light’s lead including that of the backgrounding example: geo- and heliocentrism.
3 On this issue of disagreement, I once again point to reader to both Dear’s remarks and my own. Both of us illustrate the ways in which people coherently disagreed in the Scientific Revolution.
Works Cited


