Myth, Music, and Science: Teaching the Philosophy of Science through the Use of Non-Scientific Examples

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ABSTRACT

This essay explores the benefits of utilizing non-scientific examples and analogies in teaching philosophy of science courses. These examples can help resolve two basic difficulties faced by most instructors, especially when teaching lower-level courses: first, they can prompt students to take an active interest in the class material, since the examples will involve aspects of the culture well-known, or at least more interesting, to the students; and second, these familiar, less-threatening examples will lessen the students' collective anxieties and open them up to learning the material more easily. To demonstrate this strategy of constructing and employing non-scientific examples, a lengthy analogy between musical styles and Kuhn's theory of scientific revolutions is developed.

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In teaching the philosophy of science, one of the most difficult tasks that the instructor must confront is trying to motivate the students to take an active interest in abstract and complex “theoretical” issues. All too often, the students find the various metaphysical and philosophical concepts covered in such a course to be “too difficult” and, in their eyes, "unmotivated" (especially when compared with, e.g., an ethics or aesthetics course). One obvious method of overcoming this dilemma is to provide numerous historical examples and analogies of the relevant philosophical problem, since concrete instances are frequently less complicated than general descriptions of theories, articulate the main points more clearly, and have the added bonus of being more "personal" and relatable. Thus, if one were presenting, say, Thomas Kuhn's theory of scientific revolutions, describing the conflict between the Ptolemaic and Copernican views would serve as an excellent backdrop for the introduction of Kuhn's ideas. Nevertheless, the effectiveness of this tactic will quite naturally depend on the student's overall familiarity and predisposed interest in the types of examples offered. If the students are unfamiliar and/or bored by the kinds of examples employed, the strategy will, of course, spark little enthusiasm from the class. This is a problem particularly acute in teaching the philosophy of science, moreover, since the average college student's generally low levels of instruction in science, let alone the history of science, will render the majority of real-life scientific examples as opaque as the philosophical issues they were supposed to make clear!

In this essay, one possible strategy for overcoming this obstacle, which has been culled from personal experience, will be recommended by way of demonstration. In short, the suggestion is to devise examples and analogies from outside the realm of science and its history, but which can serve to both highlight and augment the actual scientific cases typically offered, as well as provide an interesting test-bed for the exploration of the philosophical concepts underlying science. If these examples are tailored to spark the interests of the students, most notably by drawing upon the humanities and popular culture, then a marked increase in class enthusiasm and participation will be the likely result. My own personal experience with this technique had been quite rewarding and successful, although I have no data that measures the relative retention rates and comprehension that the use of such analogies may engender in the students as compared with the normal method of presentation—overall, the success of the technique will likely depend (as nearly everything in the classroom does) on the enthusiasm and creativity of the instructor (as well as the receptivity of the students). On a related point, these analogical examples need not reflect an active interest of the students. Many in the class may not be familiar with, say, classical music or mythology (which are the analogies developed in this paper)—all that is required of the prospective examples is that they have the potential to capture the attention and enthusiasm of the class (at least in comparison to the more straightforward, "no-frills" philosophic/scientific treatment of the same material, since it is this more traditional approach which the students often find less exciting). Finally, although this essay is more geared to a philosophy course in the philosophy of science, it is assumed that the same techniques will operate just as effectively in a science course that teaches the foundations of science, that is, the "scientific method", as well as those science courses that cover various philosophical dilemmas in the application or understanding of science in the larger world (e.g., the "scientific creationism" controversy, as will be discussed below). In sections I and II, consequently, we will explore two contrasting approaches to the use of specific non-scientific cases or analogies in teaching the philosophical concepts of science.

1. Myth and Science

Integrating elaborate non-scientific analogies or case studies into a philosophy of science course is particularly appropriate when the material being presented actually refers to various non-scientific aspects of culture. The following example has been adapted from an introductory philosophy course, but the topic is quite relevant to teaching the philosophy of science, especially to undergraduates. In many textbooks,[1] the nature of Western philosophy and science, as a unique form of human activity, is explicated by means of the logos/mythos distinction. "Logos" defines the philosophic/scientific way of thought, while "mythos" pertains to the older, mythological manner of conceiving the world that allegedly preceded the logos view. Thales (of Miletos) is usually identified as having espoused the first known logos centered theory of the natural world. That is, Thales did not trace the origins of natural events to a supernatural world of quarreling mythological gods, as the ancient Greeks were wont to do; rather, he assumed that the diversity and change manifest in nature all stem from a single material or natural cause, namely water.[2] This single element is more basic than the other three ancient Greek elements (fire, earth, and air) and is the common factor in their apparent transmutations into one another. Regardless of the perceived success of the mythos/logos distinction, lecturing on a topic of this form can present wonderful opportunities for introducing specific non-scientific examples into the classroom; examples that can both illustrate the author's point but also raise the student's interests in, and enjoyment of, the material.

Before lecturing on the mythos/logos distinction, the class could be presented with the following two "explanations" or "descriptions" of the same natural object.

> **(1)** [Apollo's] friendship for the young and the vigorous was frequently as dangerous as it was dear to the objects of it. He was, for instance, passionately fond of a youth named Hyacinthus. . . . One day they played a game of quoits; Apollo, heaving aloft the discus with strength mingled with skill, sent it high and far. Hyacinthus, excited with the sport and eager to make his throw, ran forward to seize the missile; but it bounded from the earth and struck him in the forehead. He fainted and fell. The god, as pale as himself, raised him and tried all his art to stanch the wound and retain the flitting life, but in vain. . . . "Thou diest, Hyacinth," . . . "robbed of thy youth by me. Would that I could die for thee! But since that may not be, my lyre shall celebrate thee, my song shall tell thy fate, and thou shalt become a flower inscribed with my regret." (Ovid, *Metamorphoses,* 10, 162-219) While the Golden god spoke, the blood which had flowed on the ground and stained the herbage ceased to be blood; and a flower of hue more beautiful

than the Tyrian sprang up, resembling the lily, save that this is purple and that silvery white. . . . The flower bears the name of Hyacinthus, and with returning spring revives the memory of his fate.

It was said that Zephyrus (the west wind), who was also fond of Hyacinthus and jealous of his preference for Apollo, blew the quoit out of its course to make it strike Hyacinthus. (C. M. Gayley, *The Classic Myths in English Literature and in Art,* Ginn & Co.: Boston, 1911, p. 93-94)

(2) The home of the common hyacinth (*Hyacinthus orientalis*) is the eastern Mediterranean region. From [a report of a journey] to Constantinople in 1554, . . . it would appear that the Turks used to cultivate hyacinths as well as tulips and daffodils in their gardens. . . . The first drawing of one is included in [a German manuscript of 1600, while another manuscript from 1613] depicts a whole series of varieties, ranging from blue and violet to red and white, single and double. At the time, the inflorescences were rather loose and did not have the fullness we associate with our garden varieties. The original type was dark-blue. Modern taxonomists treat *H. orientalis,* from which all our garden varieties have been derived, as the only member of the genus *Hyacinthus,* and have renamed the other species that used to be included in it. . . . The floral structure is [the same as] that exemplified by the tulip: 6 petaloid perianth segments, 6 stamens and a central ovary with 3 sutures, indicating its construction from 3 carpels. The numerous ovules are found in 3 locules. (H. C. D. de Wit, *Plants of the World: The Higher Plants II,* trans. by A. J. Pomerans, E. P. Dutton & Co., Inc.: New York, 1967, p. 234-235, and 230)

Overall, the juxtaposition of a quaint mythological tale and, it must be admitted, a rather dry plant classification will catch the students off guard, and should add to their enjoyment of the philosophical exploration of the viability of the mythos/logos distinction. In fact, these examples are designed to challenge the student's intuitions as to what constitutes a "good" explanation; for there is something about the mythological explanation of the hyacinth plant in (1), over and above the human interest element, that makes it a more satisfying explanation than the botanical exegesis in (2). Whereas (1) conforms nicely to the mythos idea, since the plant's mythological origins are disclosed, the logos-natural origins, or "cause", of the hyacinth is not an issue in (2). The theory of evolution would be the most likely basis for a modern explanation of this sort; which is somewhat ironic given the fact that a detailed evolutionary account of the origins of the hyacinth plant may have yet to be written. Consequently, although (2) is a modern discussion in comparison to (1), the students will have a chance to ponder the purposes and goals of different scientific “explanations" or, to use a currently popular term, “narratives". An effective scientific explanation, such as our taxonomic discussion (2), need not concern causes, which is a realization having definite repercussions for the usual "causal-centered" account of the mythos/logos distinction.[3]

If the students take exception to the type of example used above to represent the logos-based explanation, and a good discussion may center upon this point, then the instructor may want to supply additional, more causally based examples that raise different problems for the mythos/logos distinction. Consider the following:

> **(3)** I no longer learn about, and cannot understand . . . these other subtle 'causes', but if anyone tells me that anything is beautiful, as having a bright colour or a special shape or anything of that sort, I dismiss the other 'reasons' . . . and purely and simply and perhaps naively keep to this, that the only thing that makes it beautiful is the presence of, or its participation in—or whatever the relationship may be—that 'Beautiful' [the Form of Beauty]. I do not now insist upon any particular relationship, but only that all beautiful things are beautiful simply *because* of the Beautiful. (Plato, *Phaedo,* 100C-D, trans. by R. S. Bluck, Routledge & Kegan: London, 1955)

To relate Plato's theory back to our original flower case, he would have to reckon that the explanation or cause of a particular hyacinth plant is its participation in the Form of Hyacinth. Given the mythos/logos classification scheme, Plato's theory of the causal origins of beauty, or hyacinth, would thus appear to count as a species of logos explanation, since the Forms constitute an important part of Plato's *natural* world. The Forms are not supernatural beings with beliefs and desires, as in the case of Apollo, but are more akin to concepts that have been raised to the level of existing things. Of course, whether or not Plato's Forms should be included in the logos or mythos category is the very reason this example has been chosen, for it will force the students to question the viability of the distinction. Many actual scientific theories exhibit a similar ambiguity, such as Newton's belief that the stability and preservation of the material world required God's intervention ("active powers").[4] In short, the students will have a hard time trying to determine whether the logos/mythos distinction is merely arbitrary, and if mythos hypotheses can, or should, qualify as "scientific".

Constructing non-scientific examples, such as the mythological tale above, is not particularly difficult, but it does require a constant vigilance on the part of the instructor for material relevant to class topics. In some cases, however, it can take some work to actually find an appropriate set of examples to present before a class: e.g., many hours were spent in the botany section of the school library trying to find a discussion of the hyacinth plant that did more than merely list its taxonomy.

2. Music and Science

In the preceding section, the inclusion of non-scientific material into a philosophy of science course was actually warranted given the type of philosophical topic under discussion. Most of the time, obviously, this option is not available, since the subject matter does not pertain to such non-scientific issues. The typical lecture will focus exclusively upon the philosophical problems and concepts of science, and will not justify the arbitrary introduction of extraneous examples. Under these circumstances, it may nevertheless still be possible to construct a non-scientific analogy that can help *explain* the nature and purpose of a philosophical/scientific concept. In the remainder of this essay, we will explore a lengthy example that will demonstrate this very strategy: the philosophical concept will be Thomas Kuhn's notion of a scientific "paradigm", the key element in his theory of scientific revolutions; and the non-scientific topic adapted to explain this theory will be the history of musical styles and the structure of musical compositions.

The concept of a "paradigm" is the key component in the standard or common interpretation of Kuhn's philosophy of science (although Kuhn's own understanding of his paradigm concept often differs from the common interpretations[5]). Briefly, a paradigm is a guiding framework of theories or ideas that shapes and determines our understanding of the world. Newtonian mechanics, Darwinian Evolution, Freudian psychology, are a few instances of a paradigm according to the "Kuhnian" theory (whereby "Kuhnian" refers to the common interpretation of Kuhn's philosophy). For example, an evolutionist will likely interpret the data accumulated from molecular biology as confirmation of their view that species have evolved over millions of years according to a mechanistic process of genetic variation and natural selection; while a creationist will regard the same data as vindicating their theory that God simultaneously formed distinct species a mere 6,000 years ago.[6] In short, the paradigm you hold largely determines the nature of your scientific "facts", since the ambiguity and vagueness inherent in the majority of scientific experiments and observations routinely admits numerous conflicting theoretical interpretations—and it is this conjunction of observations and theoretical interpretations which constitutes our scientific "facts". The separate functions of a paradigm are as follows: the paradigm describes the entities of the particular science (planets, atoms, etc.), how these entities behave, the questions that can be legitimately asked concerning them, the techniques used to answer these questions, and the criterion of success and failure of the various answers.

Due to the enormous influence of Kuhn's philosophy, discussing the details of his paradigm concept may be an unnecessary formality, for the term seems to have entered the popular mainstream. Any comprehensive belief system, regardless of whether or not it is scientific, currently runs the risk of being dubbed a "paradigm", especially by postmodern theorists. This application of the term is not necessarily unjustified, however, since there are many non-scientific subjects that are particularly amenable to a paradigm interpretation. Music is a good example: the universal appeal of music, and its tacit understanding on the part of students, makes it an excellent candidate for pedagogical purposes.

Classical sonata form, as practiced by Haydn and Mozart, admirably demonstrates this point. Introduced in the middle of the eighteenth century, sonata form gave composers a solid framework on which to construct and arrange their musical ideas. Basically, it is a mold into which composers pour their thoughts. Sonata form incorporates a definite pattern: a short introduction, the exposition (wherein the main "subjects", or melodies and themes, of the piece are presented), the development (which explores these ideas, often in dramatic fashion), the recapitulation (a repeat of the exposition), and a short concluding coda. Classical sonata form also involves the use of a certain key relationship (not to mention the fact that the work is built on the diatonic scale). Usually the first, and most important, movement of a multi-movement work (symphony, string quartet, solo sonata, etc.) employed sonata form during the Classical period in music (1750-1820).

As is evident, sonata form (in its classical incarnation) was a perfect vehicle for the organization and structuring of musical ideas. It served many of the same functions as a paradigm (as listed above). First of all, sonata form furnished and described the entities with which the composer worked (first subject, second subject, exposition, development, etc.), as well as the ways in which those entities behave (if the movement's main key is minor, for example, the first subject will most likely be traumatic or tragic in mood). Likewise, sonata form provided the questions that could be legitimately asked, such as, "Can we introduce a new theme into the development?"; as well as the techniques and standards of evaluation for answering such questions; "Yes, you can introduce a new theme, but only as long as it doesn't undermine the recapitulation or upset the balance of the movement as a whole." Overall, just as in the analogous case of science, a musical paradigm thereby largely determines and controls the musical thoughts and experiences of the composer.

Classical music is not the only source of musical paradigms, moreover. Most popular musical forms possess their own equivalent of sonata structure, although this aspect of contemporary music is rarely acknowledged. In rock songs, for instance, one can detect a similar set of stock "entities"; such as, themes, melodies, riffs, etc. The function of these musical ideas, as well as the standards of acceptable composition, are no less circumscribed or enforced in rock music than they are in classical. Our common experience of songs, and possibly entire records, that "didn't work" or "didn't sound right" is strong testimony to the latent power of musical paradigms to shape and determine our musical expectations, and more generally, our musical experiences. Indeed, popular music may exhibit the paradigm concept even more successfully than classical, since most classical connoisseurs are only exposed to the great masterpieces of the classical "repertoire", and not the many mediocre and poor compositions that constitute the vast majority of classical works. In contrast, our common experience of much mediocre contemporary music is a constant reminder of the enormous difficulties that face successful rock composition, both in matters of structural form and inspired content.

Nevertheless, returning to our classical music analogy, sonata form also resembles Kuhnian paradigms in the manner of training. Like scientists, composers perfect their trade under the tutelage of accomplished masters, often in an apprenticeship lasting many years. The teachers of classical sonata form handed down this style, and all the entities and standards that it entails, to their pupils in the same fashion that it had been handed down to them (or as they had developed it). For example, Haydn, who helped to invent sonata form, handed down this technique to his greatest student, Beethoven. These apprentices soon learned to channel their musical thoughts through this form, much like scientists learn to construct their hypotheses within the framework of sanctioned methodologies and other well-confirmed theories. The classical music teachers, furthermore, offered many musical "exemplars" (which is a specific example of, say, a sonata form piece) that they expected their students to study and emulate in their own practice compositions. In the end, the teachers hoped that their students would go out into the musical world and extend the scope and domain of the styles that they had taught them—but, of course, within the paradigm of classical sonata form, or classical style as a whole. Thus, students should help refine and extend the paradigm, but not reject it; which Kuhn regards as the identical goal of advanced instruction in the sciences.

Another way in which musical structures resemble Kuhn's paradigm theory is with respect to the concept of meaning dependence or "incommensurability". According to the Kuhnian doctrine, the meaning of a term is determined by the paradigm as a whole; so that the term "mass", for example, has a different meaning in Newtonian mechanics than it does in Relativistic mechanics (due to the different structures of the respective theories). Likewise, such musical terms as "theme" or "chord" receive their precise meaning from the entire classical sonata form paradigm. As is the case with physical theories, you have to know the relevant theory, here, classical sonata form, to know what these words stand for in the context of that paradigm. In fact, "theme" or "chord" can take a very different sort of meaning in the context of one musical paradigm, say, romantic opera, than it does in another, such as baroque concerto form. More often than not, the style and usage of the "things" that the term refers to have changed drastically. Therefore, Kuhn draws the lesson that a strict or exact comparison of similar terms from different paradigms is, in principle, an impossible task (which he dubs "incommensurability"). It should be noted, however, that while Kuhn believed that only a part of a scientific terms meaning came from its embedding in the larger theory, the more radical reading of Kuhn’s work argues that the meaning of a term is entirely dependent on its location in the larger theory.

In addition, the Kuhnian thesis of scientific "revolutions" can be adapted to the study of musical history. In scientific revolutions, an old paradigm is replaced by the adoption of a new one; but the switch, according to the common Kuhnian reading, is really only a matter of choice.[7] Kuhn did believe that no scientific paradigm could lay claim to the "truth" in an absolute sense, since all paradigms have their own unique evolution and meaning dependence of terms (as above). Despite the existence of some general "rules of thumb" for comparing the relative merits of paradigms, such as, simplicity, consistency, quantitative precision, etc., the applications of these cross-paradigm criteria are not fixed and inviolable in each case (but, see footnote…). The more relativist interpretation of Kuhn's theory, on the other hand, holds that any method for comparing paradigms can be revised or rejected in the course of practice, thus there are no fixed general criteria or values. This interpretation of the incommensurability of entire scientific paradigms, as opposed to the incommensurability of identical terms from different paradigms (as discussed above), appears to have an analogue in classical music, as well. We cannot compare the music of the baroque period, a distinct paradigm, with the music of this century, another paradigm, to discover which one is "better". The entire core of techniques and values within these paradigms are largely different, sometimes radically so. For these reasons, we cannot compare in an exact manner, for instance, a sonata form movement of Mozart with one from Bartok.

At this point, the students will most likely want to reject the analogy being drawn between musical and physical theories. Their reasoning will probably run along the following lines: while science is concerned with trying to understand the ultimate "reality" underlying our experiences, music only aims at the production and study of aesthetically appealing musical experiences. In other words, science deals with facts and "truths" about our world, whereas music only involves, at best, someone's idea of what constitutes "good" music. In opposition, a hard-core relativist, who accepts a radical interpretation of Kuhnian philosophy, would likely retort that the acceptance of a scientific theory is as equally a matter of aesthetics or personal taste as, say, choosing your favorite rock band. Since all theories are underdetermined by empirical evidence, they argue, there must be either personal or social factors responsible for the choice of a scientific theory.[8] The realists in the classroom (of which I include myself), will find these relativist assertions perplexing, if not downright false. The teacher can instigate a fruitful discussion of this issue by presenting "what is at stake" through the use of short, direct questions: Was the choice of the Copernican over the Ptolemaic theory merely a matter of taste? Does the same hold for creationism versus evolutionism? Overall, the students may decide that the incommensurability of musical paradigms actually fits Kuhn's thesis better than the scientific paradigms for which it was designed. They may reason that, whereas personal (or social) opinion seems a perfectly legitimate explanation of musical revolutions, mere opinion does not accurately reflect all the factors involved in the choice of competing scientific paradigms. (Ultimately, the class may argue, one of the scientific paradigms will fit the evidence better than the other!)

In fact, the notion of "progress" will naturally come to the foreground in any such discussion of the comparative worth of scientific and musical revolutions. Whereas it seems perfectly legitimate, if not obvious, to claim that scientific paradigms have progressed over the history of science—that is, our current paradigms are much more successful in accounting for empirical evidence, are more unified, etc., than the older paradigms—it does not seem possible to claim that musical paradigms have "progressed" in a similar fashion. In what ways, for example, can the music of Stravinsky be judged to have progressed in comparison with the music of Bach? There are some minor aspects of the development of music where the notion of progress can be confidently asserted, of course, such as the increased numbers, quality, and range of musical instruments and performers available to the modern composer (as opposed to previous eras). But, this aspect of musical history fails to draw the correct analogy with the evolution of scientific paradigms: we do not judge that modern science has progressed due to the solitary fact that modern scientists have at their disposal a much larger assortment of accurate instruments and processes for conducting their research. Rather, we judge that science has progressed on the basis that our current paradigms *describe* (explain, represent, etc.) the world more accurately than our older paradigms. In what analogous sense, for instance, can one ascribe that the property of “accuracy of description” to modern music as opposed to Renaissance music? This apparent failure to characterize what a musical paradigm “is about”, and thus provide a basis for a comparative judgment of progress, would seem to be the source of the disanalogy in the construction of the science-music comparison. Nevertheless, it is an entirely fruitful exercise to engage in this classroom discussion, since the radical interpretation of Kuhn’s theory often deems the preference for a particular scientific paradigm to be a mere matter of taste or inclination, just as many would claim that the preference for a musical style is purely subjective. In short, the debate between the scientific realist and relativist forms the tacit backdrop throughout this entire analogical exegesis—and, not coincidentally, a great deal of the concern and interest generated by Kuhn’s theory has focused specifically on a perceived relativist threat lurking in the shadows of his paradigm concept.

If the concept of a revolution seems to raise problems for the science-music analogy, there are other aspects of Kuhn's thesis that also fail to admit an easy musical translation. The main problem centers upon the concept of an "anomaly", which is an observation or experiment that conflicts with the prevailing paradigm. According to Kuhn, anomalies are one of the primary causal agents that precipitate scientific revolutions. If enough anomalies accrue to a paradigm, which it is unable to resolve, and an alternative paradigm is available that can accommodate the anomalies, then a revolution may likely entail. Unfortunately, there would appear to be no musical equivalent of a scientific anomaly in the case of our musical paradigms, or at least none in the way that anomalies function in science. On the whole, experimental evidence does not appear to play a large role in music: it is quite difficult to come up with an historical case where observations or experimental evidence led to a musical revolution. If there were a manner in which a rough analogue of Kuhn's anomalies can be read into musical history, it would appear to resemble more an internal development than an external conflict of evidence and theory. That is, a Kuhnian revolution of scientific paradigms is rather Hegelian: a thesis (our paradigm) encounters an anti-thesis (the "conflicting" experimental evidence), which leads to a synthesis (a new paradigm which account for the problem). But with musical revolutions, the transformation of paradigms is more an evolution from within (Darwinian, or better yet, Lamarckian) than the synthesizing of an opposing, external factor. Because there are no external, empirical anomalies, musical revolutions apparently occur when composers feel the need to express themselves in a different, more unique fashion. This process thus constitutes a somewhat different type of revolution, for the composers appear to be generating their own anomalies, rather than waiting for "nature" to present them. (Alternatively, if one construes the composer's general dissatisfaction with the prevailing musical paradigm as a particular disconfirming experience, or set of experiences—that is, the composer has an experience of "displeasure", etc., when they hear the current music—then it is possible to interpret this internal sensation as piece of evidence that is *external* to the accepted paradigm's rules of composition, and thus as an anomaly every bit as externally presented as in the analogous scientific case.[9])

Interestingly, some of the difficulties with Kuhn's theory of scientific revolutions are also reflected in our musical paradigm analogy. Kuhn seemed to suggest that revolutions come in complete steps, with abrupt transitions between worldviews; as in the transition from Newtonian to Einsteinian mechanics. Many critics have alleged that this view of scientific revolutions is not supported by the historical record, or, at the least, is not typical of most theoretical transitions in the sciences.[10] Musical paradigms can successfully convey the critics' argument: musical revolutions do not occur all at once, in complete steps; rather, they evolve over long periods of time in short, careful steps. Even the most revolutionary works of such composers as Beethoven or Stravinsky were foreshadowed and based upon either their own earlier, less-radical works, or the more conventional works of other composers. In many ways, it is impossible to establish a strict dividing line between musical paradigms (or periods). Contrary to Kuhn's belief, the same is largely true of scientific revolutions. Copernicus is often credited with overthrowing Ptolemaic astronomy, but his use of the perfect circular orbits of that earlier tradition has often led to his being branded "the last of the Ptolemaic astronomers". One might try to salvage Kuhn's thesis by declaring that all scientists, or composers, who "stretch" the rules of their paradigm are, in fact, creating a new paradigm. Yet, if this doctrine were accepted, then every scientist or composer in history would possess, by default, their own unique paradigm; and, consequently, the concept of a revolution would no longer appear to be even applicable. Likewise, Kuhn's notion of the incommensurability of scientific terms is not exempt from criticism. Just as a scientist can understand and relate the different meanings of "mass" in Newtonian as well as in Relativity theory, so can a composer understand the meaning of "chord" in romantic and baroque music. Therefore, a radical interpretation of Kuhn's doctrine of incommensurability (where, as described above, the meaning of a term is completely different in a rival paradigm) is not supported by the historical evidence (as Kuhn would agree; 1970, p. 202)

To summarize some of the main themes in this discussion, we have provided the following outline, which may also be of assistance in the classroom:

Scientific Paradigms: Evolution // Creationism

1) Entities: (Evol.) species, animals, plants, genes, etc. // (Creat.) same entities, but with an original supernatural designer (God).

2) Behavior of entities: (Evol.) genetic variation, natural selection, plus possible other unknown natural mechanisms // (Creat.) God's initial creative act, and very limited genetic variation and natural selection.

3) Legitimate questions: (Evol.) How did this species evolve from this earlier species? // (Creat.) Why did God create this particular species?

4) Techniques for answering questions (and standards of success): (Evol.) Are there relevant structural, genetic, anatomical, spatial (location), temporal (in geological strata), etc., similarities between the species? // (Creat.) What use is this species to humans or environment (which is possibly not answerable by humans)?

5) Exemplars (successful previous application of theory): (Evol.) observed genetic variation and natural selection in living species (fleas, moths, etc.), anatomical and genetic similarities in species, and fossil records // (Creat.) fossil records and/or other evidence that allegedly disproves evolution.

6) Incommensurability: 'human' in evolutionary theory means an animal species that has evolved over time through a natural process of genetic variation and natural selection (not specifically designed) // 'human' in creationism means a species of being specifically designed by God to be masters of the planet earth.

Musical Paradigms: classical sonata form // rock-n'-roll song
1) Entities: (class.) theme, chord, development, exposition, etc. // (rock) theme, chord, riff, guitar solo, etc.

2) Behavior of entities: (class.) first theme in exposition is in main key // (rock) guitar solo is in middle of song after presentation on main melodies.

3) Legitimate questions: (class.) Can a new theme be introduced in the development section? // (rock) Can the song last for more than three minutes?

4) Techniques for answering questions (and standards of success): (class.) Yes, but as long as it doesn't undermine the recapitulation. // Yes, but don't expect much radio airplay, or video exposure.

5) Exemplars (successful previous application of theory): (class.) a sonata form movement by one of the acknowledged master, such as Haydn, Mozart, etc. // a hit song by one of the great rock bands, such as Beatles, Rolling Stones, etc.

6) Incommensurability: 'theme' in classical sonata form is designed for maximum development capacity, and is (usually) in either tonic or dominant key // 'theme' in rock music is usually designed for maximum melodic capacity, must allow lyrics to be set to the theme, and may not strictly follow the tonic-dominant tonal scheme.

Needless to say, many of the entries in the above outline are open to dispute. In fact, the instructor may devise such a list in the classroom, or ask the students to come up with one of their own, thus providing an additional means of promoting discussion.

3. Conclusion

Although this essay has centered upon two case studies, namely, the mythos/logos distinction and Kuhn’s theory, the reader should not draw the conclusion that only very specific and technical topics in the philosophy of science are amenable to an analogical treatment. Every basic topic in the philosophy/methodology of science would seem to benefit from a comparison with ordinary experiences and popular culture, as outlined above, since most students will generally comprehend and master the material more quickly and effectively if the material is presented against this backdrop. In some cases, in fact, the students are already tacitly familiar with the substance or practice of these general philosophical concepts of science, but are not aware of it, so the use of analogies based upon common experiences can draw out the conceptual content of these ideas quite effectively. The "Scientific Method" of hypothesis testing is a case in point: many students may regard the "hypothetico-deductive" method (as a part of the scientific method) as a form of reasoning drastically removed from their own, non-scientific and ordinary approach to the world—but, this is not true at all. All people (even students) frame hypothesis to explain and understand phenomena, a process that involves testing the hypothesis based on its derived predictions. For example, if a person turns the key of the ignition in their automobile, and nothing happens, one of the first hypotheses that an experienced driver may frame is that "the battery is dead". In order to test this hypothesis, however, the driver will try to turn on the radio or some other electrical component to determine if the battery is indeed dead (or at least that the problem is located somewhere in the electrical system). If the radio is working, of course, then the hypothesis has failed a test (disconfirmation), and is automatically rejected as a suitable explanation for the failure of the failed ignition (although the introduction of "auxiliary hypotheses" to account for the failure can often take such mundane example in to more interesting and scientifically realistic waters). In summary, every-day analogies can be utilized quite easily and effectively when discussing most of the concepts that underlie the philosophy of science.

In conclusion, there are many benefits to be gained by the use of non-scientific examples and analogies in teaching courses in the philosophy, history, or methodology of science. These examples serve two general, and difficult, needs which most instructors face, especially when teaching lower-level courses: first, they assist in motivating the students to take an active interest in the material, since the examples concern more familiar aspects of the culture in which they have a predisposed interest; and second, the examples will express difficult material against the backdrop of a familiar, non-threatening domain of common experiences—and this process will make the material seem less forbidding and alien. The more advanced the course becomes, obviously, the less need there will be for such tactics; yet, even graduate students will find such examples instructive and entertaining. At the very least, the utilization of non-scientific examples can assist in breaking the "barrier of silence" that all too often rises up between instructor and student—and any means of initiating fruitful conversation and dialogue within the classroom is to everybody's benefit, both educationally and personally.

1 For example, Donald Palmer, *Does the Center Hold?: An Introduction to Western Philosophy,* 2nd ed. (Mountainview, CA: Mayfield, 1996), 8-10.

2 More precisely, Palmer holds that Thales' hypothesis presupposes the following three beliefs: (1) if there is change, then there must be something behind the change that does not itself change; (2) if there are "many", then there must be a "one" behind the "many"; and (3) that the human mind has the capacity to understand the "unchanging one" listed in (1) and (2). (p. 7)

3 In addition, there are many minor variations on the myth of Hyacinthus that call into question the similarity of the mythological flower and its modern namesake. For example, despite being mentioned by our author, many renditions of the Hyacinthus myth do not incorporate the following details: "[Apollo] then, to confer still greater honor [on the death of Hyacinthus], marked the petals [of flower] with his sorrow, inscribing 'Ai! ai!' upon them." (Gayley, ibid., 94) Given my decidedly limited knowledge of botany, such markings do not appear to be a basic feature of the modern hyacinth plant. Hence, another topic of conversation in the classroom may center upon the very real possibility that the hyacinth of ancient myth and the hyacinth of modern botany are different species of plants.

4 A nice brief discussion of this aspect of Newton's thought can be found in, A. Gabbey, "Newton and Natural Philosophy", in *Companion to the History of Modern Science,* G. N. Cantor et al., eds. (Routledge: London, 1990), 243-264.

5 The work in which Kuhn first presents his theory is, of course, *The Structure of Scientific Revolutions,* 2nd. ed., Chicago: University of Chicago Press, 1970. The book first appeared in 1962, but the second edition includes a postscript wherein he attempts to answer the critics. In this second edition, Kuhn attempted to meet the many problems raised over the definition of “paradigm”, which seemed rather vague to some commentators, by introducing the concept of a “disciplinary matrix” (p.182). A disciplinary matrix largely includes and refines the earlier “paradigm” notion introduced in the 1962 edition. Unfortunately, the term “paradigm” caught on with the philosophical crowd, and ultimately the general populace, whereas the term “disciplinary matrix” did not (or at least has not). In this essay, consequently, we will follow the common interpretation of Kuhn’s theory of science and examine the concept of a “paradigm”, even though the more correct term that refers to Kuhn’s concept should really employ “disciplinary matrix” in place of “paradigm”. In addition, much of the material discussed in this essay is contained in the first few chapters of Kuhn (1970), and the postscript. For criticisms of Kuhn’s initial presentation of paradigms, see; D. Shapere, “The Structure of Scientific Revolutions”, *Philosophical Review,* 73, 1964, 383-394.

6 It is simply being assumed, here, that scientific creationism counts as a “scientific” paradigm, although many may doubt the accuracy of this classification given the very non-scientific basis and underlying purpose of this belief system.

7 Although some passages in Kuhn can be read as favoring a radically relativist account of scientific revolutions, such that “anything goes” in paradigm change (1970, p.150-151), Kuhn did believe that science is progressive, such that new paradigms are more successful than the old paradigms (which they replace) in meeting his “value” criteria of theory change (p.205-206). In particular, the criteria for accuracy and scope in predictive power would seem to be a non-negotiable value, thus it is very difficult to saddle Kuhn’s own conception of scientific revolutions with such a non-rational, relativist interpretation.

8 The social constructivist school, in the branch of philosophy known as the sociology of scientific knowledge, attempts to reduce many disputes and conflicts in the history of science to socio-political factors in the larger culture of the time. See, for example, H. M. Collins, *Changing Order: Replication and Induction in Scientific Practice,* London: Sage, 1985.

9 This suggestion for an “external” reading of musical analogies I owe to an anonymous referee from *Science & Education.*

[10] For a lengthy discussion of this topic, and many more, see; I. Scheffler, *Science and Subjectivity,* 2nd ed., Indianapolis: Hacket, 1982.

REFERENCE LIST

Collins, H. M.: 1985. *Changing Order: Replication and Induction in Scientific Practice.* London: Sage.

Gabbey, A.: 1990. "Newton and Natural Philosophy", in *Companion to the History of Modern Science,* eds., G. N. Cantor et al. Routledge: London, 243-264.

Gayley, C. M.: 1911. *The Classic Myths in English Literature and in Art.* Boston: Ginn.

Kuhn, T.: 1970. *The Structure of Scientific Revolutions,* 2nd. ed. Chicago: University of Chicago Press.

Palmer, D.: 1996. *Does the Center Hold?: An Introduction to Western Philosophy,* 2nd ed. Mountainview, CA: Mayfield.

Plato: 1995. *Phaedo,* trans. by R. S. Bluck, Routledge & Kegan: London.

Scheffler, I.: 1982. *Science and Subjectivity,* 2nd ed., Indianapolis: Hacket.

Shapere, D.: 1964. “The Structure of Scientific Revolutions”, *Philosophical Review,* 73, 1964, 383-394.

de Wit, H. C. D.: 1967. *Plants of the World: The Higher Plants II,* trans. by A. J. Pomerans, New York: E. P. Dutton.