Chapter 14

Contrasting Competitive Plausibility

Throughout this study we have seen that themes from many different cultures played a significant role in the genesis of modern science. Nevertheless, the history of modern science continues to be conditioned by a Eurocentric perspective in which non-European cultures are perceived to have made little or no contributions, and many of their influences are, instead, traced back to minor themes in the ancient Greek tradition. An illusory history of science is thereby constructed, which continues to shape thinking even today. Thus the biologist Lewis Wolpert writes:

> The peculiar nature of science is responsible for the fact that, unlike technology or religion, science originated only once in history, in Greece. Most scholars are agreed that science had its origin in Greece, though those that equate science with technology would argue differently. This unique origin is important for understanding the nature of science, since it makes science quite different from so many other human activities, for no other society independently developed a scientific mode of thought, and all later developments in science can be traced back to the Greeks. (Wolpert 1993, p. 35)

Such views are by no means confined to scientists—even Thomas Kuhn, in his work *The Structure of Scientific Revolutions,* which can be seen as one of the most important epistemological influences on the recent multicultural turn in many areas of knowledge, appears to become equally Eurocentric when he considers the history of science:

> Every civilization of which we have records has possessed a technology, an art, a religion, a political system, laws and so on. In many cases those facets of civilizations have been as developed as our own. But only the civilizations that descend from Hellenic Greece have possessed more than the most rudimentary

A. Bala, *The Dialogue of Civilizations in the Birth of Modern Science*

> science. The bulk of scientific knowledge is a product of Europe in the last four centuries. No other place and time has supported the very special communities from which scientific productivity comes. (Kuhn 1970, pp. 167–168)

As revealed in the passages above the Eurocentric intellectual history of science is, to a large extent, really a history of the Greek roots of modern science. Other histories, equally Eurocentric, which trace the roots of science to Europe in the scholastic age, are not so much intellectual as cultural histories, see the medieval period as formative for the political, social, or economic conditions that facilitated the rise of modern science. Duhem is one exception—he traced the rise of modern science to Buridan's impetus theory and Oresme's geometric interpretation of certain arithmetical values, which he considers to have paved the way for the law of inertia and Cartesian analytic geometry in the seventeenth century. However, most historians of science have been reluctant to follow Duhem and locate the birth of modern science in the medieval fourteenth century. Indeed the discoveries of Buridan and Oresme only continue the work done by Arabic studies of the impetus theory and geometric approaches to algebraic problems. If Duhem is right, then we would also have to locate the birth of modern science in the Arabic world, but this would be to ignore the distinctive features of modern science that make it different from the tradition of Arabic science.

The main reason Eurocentric interpretations appear so plausible is that many of the major themes that influenced modern science can indeed be traced back to Hellenistic thought—we find the application of mathematics to natural phenomena in Ptolemy and Archimedes, the interest in mechanical systems in Archimedes, the Hermetic tradition in Alexandrian Hellenistic thought, the atomic theory in Leucippus and Democritus, and so on. However, explaining modern science as a process of continuing the developments initiated in Hellenistic science creates a number of problems. First, this tradition was also inherited by the Arabic and Byzantine cultures. The Hellenistic tradition was carried by them for several centuries (in the case of the Byzantines, for more than a millennium). We need to develop auxiliary constructions to explain why the tradition remained so sterile in these two cultures—insofar as the emergence of modern science is concerned—but took off suddenly in modern Europe once it was transmitted there in the scholastic period.

Second many of the themes of modern science can also be traced back to Chinese and Indian thought. Mathematics played an important role in Chinese astronomy (especially algebra) and was a highly developed science among Indian mathematical astronomers. The Chinese had developed far more powerful mechanical technologies than the Greeks. The sophistication of Indian atomic theories was only exceeded in the nineteenth century, and, even in China, atomic theories were proposed by the Mohists although they did not develop far. Hence one could, in principle, trace most of the relevant themes found in Hellenistic thought to both the Indian and Chinese traditions simply by virtue of the prolific range of ideas generated there in the Axial Age.[1] Hence only the fact that modern science developed in Europe (which happened to include Greece) makes it seem reasonable to trace current scientific ideas to the Axial Age Greek world. If modern science had developed in China or India, then their Axial Age thinkers would have provided sufficient material for Sinocentric or Indocentric histories analogous to the Eurocentric account that dominates thought today.

This suggests that Greek science did not really play the unique role now assigned by historians to it. It came to be seen as the only predecessor of modern science simply because it possessed a sufficiently rich reservoir of ideas for historians to construct it as such by selective appropriation of themes guided by the hindsight knowledge provided by modern science. This process is analogous to the way theological hermeneutics finds the discoveries of modern science in selected sacred texts— the texts treated as significant are now Greek philosophical and scientific texts. The suspicion that this may be the case becomes reinforced when we consider that Greek science did not develop into modern science in all of the cultures that inherited it before Western Europe—the Hellenistic world itself, as well as the Byzantine and Arabic civilizations. This triple failure of the tradition to generate modern science can, of course, be explained by appeal to sociocultural or religious factors formulated in the form of answers to the question, Why did modern science not develop in civilization X? However, we have already had occasion to show the questionable status of the question. It is far easier to suppose that Greek culture was never on the verge of modern science than to find sociocultural or religious obstacles in diverse cultures for their perceived failure to develop modern science in spite of having at hand the resources to do so.

Hence, the mere presence of themes found in modern science in a particular culture—like the Greek—cannot be sufficient to claim that they inspired a similar emergence in modern science without other conditions being met. These themes must be developed sufficiently to become useful to the creators of modern science; and they have to be selected and fused together into a coherent new structure. This study has argued that Arabic thinkers, rather than the Greeks, made mathematical realism a dominant theme, and provided an exemplar of a mathematical realist theory in Alhazen optics. It was this achievement that made mathematical realism seem a plausible approach to nature. Second, it was the Chinese who developed mechanical technologies to a level where a mechanistic conception of the universe could become plausible, and it was Indian mathematical atomism (inspired by Indian atomism) that made possible the atomistic analysis of matter, its properties, space, and time at the dawn of modern science. Moreover, the peculiar emphasis on sun-centeredness and vital forces in Egyptian Hermeticism motivated the urge to see the sun as the center of the planetary system, and inspired Newton in his conception of a gravitational force that drew diverse bodies in the universe to one another. The unique European achievement in the modern age—an age formed by the achievement itself—was to formulate the heliocentric theory, draw on highly developed themes from a diversity of cultures, and integrate them into a new science able to consolidate the theory.

Hence, the European achievement is more radical than Eurocentric interpretations suggest—it did not merely continue the Greek heritage of science, or for that matter the Arabic, Chinese, Indian, or Egyptian traditions, but broke with all of them by creating a science forged from elements drawn from every one of them. This would not require us to deny the contributions of Hellenic and Hellenistic science; it would only put into question Eurocentric histories that one-sidedly stress the Greek roots of modern science, but ignore other cultural contributions. Such histories underestimate the uniqueness and novelty of modern science by reducing it to an outcome of Greek science. Our historical account is more faithful to the perception of the creators of modern science that they were engaged in a war of the ancients and moderns in which ancient Aristotelian science, assimilated only a few centuries earlier, had to be subverted to make way for modern science.[2]

If the birth of modern science can be attributed to the confluence of four streams of science—the Arabic, Chinese, Indian, and Egyptian—entering Europe from outside, then it can also explain why modern science developed within Europe and not elsewhere. There is no need to appeal to sociocultural values in non-European cultures that led to their failure to arrive at modern science. Many of the debates on this question have focused on Chinese and Arabic science because they are considered to have been sufficiently advanced to have produced modern science, but did not. The blame for the Chinese failure has been attributed to various cultural, social, and institutional causes, but there is a more direct explanation. The Chinese never acquired the Arabic tradition of science as the Europeans did, and therefore they were in no position to combine a mathematical realist orientation with their mechanical achievements to create modern science.

It has also been argued that Arabic science was on the threshold of modern science simply because it had inherited Greek science. However, while Arabic civilization did inherit the Greek corpus, as well as the Indian and the Hermetic traditions, it did not absorb Chinese science, and especially its technology, to the same extent as Europe. After the Mongol destruction of the Abbasid Caliphate the Islamic world collapsed into disarray (exacerbated by the terrible plague that followed), and perpetual invasions by Mongols, Turks, and other nomadic people created too much instability for Chinese technology to be absorbed into productive activity—even though the invaders themselves converted to the religion of Islam. Hence, the Renaissance combination of artist and craftsman, like Leonardo da Vinci, who united the mathematical realist approach of Arabic science with interest in mechanical devices that were ultimately of Chinese-inspired origin, could not develop here. Such artist-craftsmen laid the basis for the mathematical mechanical vision of the future.

The failure of modern science to develop in India can be explained by the straightforward fact that it was not an arena for the influx of Chinese technology. Instead India in the north came under Islamic rule in the eleventh century, and the turmoil of the Arabic world after the Mongol conquests did not facilitate the flow of Chinese technologies from the north. Hence one important factor that favored Europe over the Arabic world and India was the impact of Chinese technology there—without which the mechanical vision of the universe would not have emerged.

The multicultural impact on Europe would also explain why Greek science failed to develop into modern science. It could not have—it lacked Indian mathematics, and it lacked the mathematical realist orientation of the Arabic scientists, as well as the significant exemplar of a mathematical realist theory of science provided by Alhazen's optics, and Chinese mechanical technologies. Given this vast abyss separating Greek science from modern science, it simply did not have the resources to develop into modern science. Moreover these resources were not even available at the time Greek science began to decline—most of the advances in the Arabic, Indian, and Chinese traditions that made modern science possible came centuries after the decline of Hellenic science.

Consider Cohen's argument that intellectual factors alone cannot have led to the breakthrough to modern science in Europe because these factors were also present in the Arabic world. To explain why the advance happened in Europe and not in the Arabic world we have seen Cohen appeal to what he describes as the "European Coloring." He lists the factors that went into this "Coloring" as follows: the urge to make very accurate observations of natural phenomena; the tradition of the application of mathematics to art by Renaissance artists; the positive valuation of manual labor in Europe; a greater receptiveness to magical notions and practices; and the receptivity to corpuscular views, which fortunately integrated extremely well with the universe of mathematical precision.

However, the dialogical approach this study has adopted allows us to recognize that these factors did not fortuitously arise in Europe de novo, as Cohen supposes. They were the outcome of Europe's interaction with other cultural influences. The urge for accurate observation and application of mathematics to art was largely inspired by the impact of the Arabic world (and particularly the Alhazen optical theory); the positive valuation of manual labor came from the recognition of the productive possibilities inherent in the mechanical technologies from China; the receptiveness to magical notions and practices is traceable to the impact of Egyptian Hermetic philosophy; and the union of the corpuscular philosophy with the universe of precision was made possible by Indian mathematical theories. Although it could be argued that the "European Coloring" was different from the Islamic one around 1600, the difference itself can be explained not by Eurocentric appeal to some mysterious essence present in Europe from ancient times, but as the outcome of changes wrought in Europe through its dialogue with Asian and African cultures.

However, we cannot ignore the role of the Copernican theory in functioning as the attractor around which the different multicultural streams could coalesce. The mathematical realism of Arabic thinkers was drawn into it by the insistence that astronomical theory should provide both a mathematically precise and physically plausible account of planetary motion. Chinese astronomical ideas became a part of this theory as it expanded to include evolving stars, comets, nova, and other parts of a changing universe of objects in a space construed as both infinite and empty. Indian mathematical ideas were drawn into it through the work of Indian astronomers, and these ideas also facilitated the ontological and analytical atomism of modern science. And Egyptian Hermetic conceptions of the sun as deity inspired its central heliocentric idea and the concept of gravitational force. The Copernican theory was a distinctively European achievement—linked to old Europe through Aristarchus and new Europe through Copernicus. Given its power to focus relevant elements of other traditions into its research program, it also explains why modern science developed in Europe and not elsewhere.

Thus this dialogical account is able to give one explanation for why modern science developed in Europe and not elsewhere. First, it was in Europe that the Copernican theory developed. Hence in no other culture did such an attractor for multicultural traditions exist. Second, it was in Europe that it became possible for the interaction of Arabic, Chinese, Indian, and Egyptian sciences to occur. By contrast Eurocentric accounts of modern science require one set of factors to explain why it developed in Europe, and another set to explain why it failed to emerge elsewhere—with a separate set of specific factors to account for the failure of Arabic, Chinese, and Indian sciences, respectively. Hence, in terms of economy of thought and explanation the dialogical model is more competitively plausible than the Eurocentric one.[3]

However, the dialogical answer to Needham's Grand Question also has much wider cultural implications. Today we find ourselves in the middle of a so-called "science wars," with feminists, environmentalists, and multiculturalists turning to premodern traditions to rectify perceived limits in the system of knowledge generated by modern science. To those who subscribe to the Eurocentric vision of the history of science, such attempts might appear perverse movements inspired by antiscience sentiments returning to myth, superstition, and irrationality. However, if modern science did progress through dialogue with premodern traditions of knowledge—indeed its birth itself was the outcome of such a process—then there is good reason to suppose that dialogue with these traditions may tap yet unexploited reservoirs of knowledge for future science. Hence the dialogical history of science opens the door to dialogical approaches to science in the future. A Eurocentric history does not give us any reason to open the door to a dialogue; worse, it may lead us to shut it. Hence the science wars are not just about the history of science—they are also about the future of science.