Kuhn, Truth, and Scientific Progress

In his famous and controversial book *The Structure of Scientific Revolutions*, Thomas Kuhn presents science as a process by which paradigms (broadly defined theories or explanations for phenomena) are developed, expanded, overturned, and replaced. His account seems to suggest that it is the nature of science to endlessly go through this radical revision process, and he expresses doubts about whether it is useful to "imagine that there is some one full, objective, true account of nature and that the proper measure of scientific achievement is the extent to which it brings us closer to this goal."[1] However, as biologist John A. Moore suggests, scientific fields do frequently reach a point at which a paradigm becomes "settled science"; i.e. where it could not conceivably be wrong, and thus can be safely accepted as "truth." Often this occurs when our scientific tools and methods become sufficiently advanced that an object or phenomenon that could once only be investigated indirectly can now be directly observed. Other times the preponderance of evidence for a paradigm is simply so great and its explanatory power so all-encompassing that it becomes inconceivable that it could ever be entirely disproven. Thus, contrary to Kuhn, science does usually progress toward a stable view that can be reasonably considered to represent objective reality.

Frequently, a paradigm becomes essentially indisputable "settled science" when improvements in our scientific instruments allows us to directly observe what we could previously only study by means of indirect evidence. Consider the shape of the earth. In antiquity, philosophers concluded that the earth was spherical, rather than flat, by indirect observations, noting, for example, that certain stars could not be seen from certain geographic locations, or that ships seemed to vanish from the bottom up over the horizon. Famously,

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[1] Thomas Kuhn, The Structure of Scientific Revolutions, 3rd ed. (Chicago: University of Chicago Press, 1996) 171.

Eratosthenes of Cyrene measured the circumference of the earth with surprising accuracy using basic trigonometry by observing the elevation of the sun on the summer solstice at Alexandria and at Cyrene. Later on, Magellan's circumnavigation of the globe provided further evidence that the earth was a sphere. However, had there been any remaining doubts about the spherical shape of the earth, the first photos of the earth taken from outer space in the mid-20th century would have decisively put them to rest. Man had now directly seen the earth. It was a sphere, and it seems more than safe to say that it is impossible that any future evidence will ever disprove this fact. That is, it is safe to say that there will never be a scientific revolution that will overturn the round-earth paradigm. Similarly, consider the field of geography.

> The earth is not infinite, and some of the geographical questions have been answered. For example, not many new continents have been discovered lately, and, in fact, not many areas within the continents remain unknown to geographers. Thus, in the broad sense, discovery is over—only microgeography remains.[2]

There are, of course, some things that we cannot and may not ever be able to directly observe. Consider the question of the nature of light. Given that light itself *is* the means by which we see things, it seems impossible that we will ever be able, through any sort of "microscope," to see how light works or what exactly light is. However, we can at least conclude that not all sciences have gone continually through the cycle of revolutions that Kuhn outlines, since, in at least some fields, the goal of general understanding of a phenomenon has, through direct observation, been decisively achieved.

Other times, when we cannot see something directly, as indirect evidence amasses our model of it seems to asymptotically convergence toward objective reality. Consider the atom. In the early days of modern atomic theory, J. J. Thomson, in his work with cathode ray tubes,

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[2] John A. Moore, "Kuhn's 'The Structure of Scientific Revolutions' Revisited," The American Biology Teacher 42.5 (1980), 21 October 2008, <http://www.jstor.org/stable/4446944>, 302.

discovered the electron and hypothesized that the atom consisted of these negatively charged particles moving around in a positively charged medium (the "plum pudding model"). Later, Ernest Rutherford, from the results of his famous gold foil experiment, concluded that the positive charge and most of the mass of an atom was concentrated in a central nucleus, around which the electrons orbited. Further experiments and modifications to the model added neutrons to the nucleus (Chadwick), confined the orbiting electrons to distinct energy levels (Bohr), and revised the electron orbits from being similar to planetary orbits to more chaotic probability distributions (Schrödinger).[3] This progression suggests that, far from going through the endless and futile cycle of near-complete revisions that Kuhn's analysis implies, our image of what the atom actually "looks like" has been, through successive refinements over the years, gradually coming into focus. Thus, there is reason to believe that, over time, scientific theories do, in fact, approach something that we may reasonably call reality.

Finally, sometimes the mere preponderance of evidence in favor of a paradigm, the comprehensiveness of its explanatory power, and its having stood up to testing for so long make its falsification inconceivable. As Moore argues,

> It is not unreasonable to suggest that a paradigm might reach such a state of reliability and universality that it can be accepted as an elegant and emotionally satisfying way of looking at a phenomenon. For all intents and purposes, except the philosophical, it can be accepted as "truth."[4]

He offers genetic inheritance as an example, arguing that, in a broad sense, this theory explains everything we could expect a theory of heredity to explain (though, of course, there is still much "normal science" work to be done in matching genotypes to phenotypes).[5] The evidence is so

[3] Note: Kuhn argues, probably correctly, that it is oversimplifying and misleading to refer to specific individuals as having made specific discoveries at precise moments in history. This paper does so merely in deference to convention, so as to present the progress of a specific field in the way familiar to most readers.
[4] Moore, 301.
[5] Moore, 301.

overwhelming that "unless some grand cosmic joke has been played upon us, there is no conceivable way that the chromosome theory of inheritance could be voided."[6] He notes that this theory of heredity has, indeed, become so developed and so well supported "that other forms of inheritance, such as via plastids, can be understood as minor alternate pathways."[7] An important justification for this view that some scientific theories are true "beyond all reasonable doubt" is that, as evidence for a paradigm mounts, the burden on any would-be alternative theory to better explain all the evidence that seems so strongly to point to the current paradigm must at some point become simply too great. Again, take atomic theory: if atomic theory as we know it were somehow *overturned* in a Kuhnian revolution (not merely modified by the gradual process discussed above, but shown to be fundamentally wrong as a view of what matter is made of), any new paradigm that replaced it would have to explain why it *seems* that essentially all the relevant evidence of the natural sciences—physics, chemistry, biology, etc.—attests to and is explained by modern atomic theory. The fact that that seems like an impossible task is good reason to conclude that the current model is, in fact, the correct one.

At the beginning of his book, Kuhn, referring to obsolete scientific theories, soberingly notes that "if these out-of-date beliefs are to be called myths, then myths can be produced by the same sorts of methods and held for the same sorts of reasons that now lead to scientific knowledge."[8] Yet in view of the evidence presented here, it seems Moore is justified in proposing that "perhaps Kuhn's notion of ever-recurring scientific revolutions that usher in new paradigms may describe better the past than the future."[9] As we have seen, this is almost certainly true in at least some fields. In others, we can still readily imagine a Kuhnian revolution

[6] Moore, 301.
[7] Moore, 301.
[8] Kuhn, 2.
[9] Moore, 302.

occurring. Returning to the question of light, the bizarre notion of the dual wave/particle nature of light might well one day be overturned by some more unified theory (thought what such a theory might look like is difficult to even imagine). Still other fields (such as many of the social sciences) have arguably yet to acquire a paradigm at all. For these, Kuhn's revolutionary cycle has yet to even begin. Yet history suggests that when these cycles do finally begin in these fields, they will go somewhere, progressing toward the point where they arrive at a theory that can reasonably be accepted as the truth.

Bibliography:

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