

Notes on Thomas Kuhn, and *The Structure of Scientific Revolutions*

Thomas Kuhn (1922 – 1996) began critiquing the standard theories of the linear progression of science (Koestler's approach) while a doctoral student in physics at Harvard in the '40s. He was studying Aristotle's physics, and puzzling over why such obviously flawed notions of matter and motion could have been taken seriously for so long, when he realized that Aristotle's theory actually made more sense, when examined as an intellectual totality. Aristotle's theory of motion, for instance, refers to motion as change in general, not simply physical change ("What are Scientific Revolutions?"). This leads to his major theoretical contribution to history and philosophy of science, *The Structure of Scientific Revolutions* (1962).

His central critical focus is the idea that science progresses linearly – new ideas simply add to one another. His study of textbooks (ch. XI of *Structure*) indicates that this was by far the dominant (still is?) approach to describing history of science. The central problem with this approach (other than its historical inaccuracy) is that it fails to explain how scientific change happens – both how we are able to embrace a new idea despite its newness, and why it is that scientific change is a subject of debate in the first place. It makes scientific change invisible – we cannot really see it, let alone explain why it happens.

The concept he introduces to replace this linear theory is the notion of the **paradigm**. Kuhn's central argument in *Structure* is that scientific ideas do not occur in vacuums; but rather occur in intellectual paradigms. Kuhn defines paradigms a bit minimally; "law, theory, application, and instrumentation together – [which] provide models from which spring particular coherent traditions of scientific research" (*Structure* 10). It may help to think of paradigms as almost like scientific ideologies – bundles of undergirding ideas about what constitutes scientific knowledge, accepted definitions of scientific terms. These paradigms frame what scientific questions are asked, how they are asked, and to what extent they can be answered. In short, they define "**normal science**" (another Kuhn-ism). Paradigms can be both large (Bacon's method sets a paradigm for natural science), and small (there are paradigms for how to do research in specific subdisciplines of each natural and social science).

Kuhn notes that scientific research can happen in the absence of a paradigm, but that it happens more randomly – all facts have more equal status, it's hard to draw distinctions about what to rule in and out of your research. For a few concrete examples, think about how science proceeds when a new field is developing. James Watson's *The Double Helix* describes the search for DNA when people weren't really geneticists but biochemists and chemists bumbling around (sorry, Mike!). Similarly, Bruno Latour's *Laboratory Life* describes the search for the structure of a hormone as a battle between two competing paradigms of how to do endocrinology.

Central to understanding the paradigm is to understand the way in which individual scientific concepts gain legitimacy by being in a paradigm. Kuhn describes the concepts of Aristotelian physics as "fit[ting] together, to lend each other mutual support, and thus to make a sort of sense collectively that they individually lack" ("What Are Scientific Revolutions?"). Part of the failing of historians of science, then, is to focus overmuch on individual concepts' advance or debate, without understanding the intellectual framework that produces them. The second major failing is that in our naïve belief in inevitable scientific advance (*pace* Koestler) we do not give proper intellectual attention to the coherence of previous theories.

While paradigms can be rational and coherent (even if they're not particularly accurate by modern standards), they don't develop, or become dominant (become accepted over a competing paradigm) fully on rational terms. Kuhn does think that when two competing paradigms exist, one wins out for essentially pragmatic reasons – it answers more scientific questions, or answers them more precisely, than its competitor (*Structure* 23). And yet, he uses psychological and religious language to describe the paradigm shift, describing it as a gestalt move (it happens all at once or not at all, not piecemeal), and characterizing those making the

shift as having a “conversion experience” (*Structure* 151). This undercuts his evidence-based characterization of the adoption of the paradigm.

So more often than not, a paradigm governs how we see and think in science, and defines legitimate scientific problems (“**normal science**”). The smaller technical scientific questions we work out through the course of normal science are considered **puzzles**. Kuhn’s study of history of science reveals that change does not happen gradually and incrementally, one idea at a time. Rather, change happens in **revolutions** – revolutions where one paradigm is replaced with another. Cracks appear in the dominant scientific paradigm (questions that can’t be answered become more troubling or more common – Kuhn calls them **anomalies**), and new thinkers come up with ideas that don’t fit the model of normal science. Kuhn stresses that it tends to be younger thinkers coming up with the new ideas (they’re less vested in the dominant paradigm), and that older scientists tend to be the most resistant to change (they’re most vested in the success of the dominant paradigm – it’s defined their careers). These new ideas take time to become accepted (as Koestler’s history of the switch from geocentrism to heliocentrism exemplifies).

These revolutions are often protracted, and highly conflictual; indeed, Kuhn describes revolutions as preceded often by crisis. This is so in part because of another common feature of paradigms. Like ideologies, they are often more implicit than explicit. The rules of normal science in a particular subdiscipline are not explicitly spelled out. While scientists can explain the conditions of normal science for their field when pressed, the rules are not adopted *consciously* as a totality. This is why when a field is in crisis because the dominant paradigm isn’t working, one response is that the rules for doing normal science become loosened (while there may not yet be a new paradigm on the horizon, the old paradigm has less coercive power on the work in the field). This helps foment the development of new paradigms.

Kuhn’s theory is important in understanding not simply the history of science, but its practice – you can probably see that his theory would have important implications in sociology (understanding how scientific communities work becomes hugely revealing), philosophy (how scientific truth gets established, what the criteria for truth are), and history (who historically is in the scientific community? Have paradigms always been formed and devolved similarly?). Scholars deeply disagree about how broadly to define and apply his theory of paradigms, and paradigm shift. (Kuhn himself retreats from some of the more sociological interpretations of his theory towards the end of his career.)

Further reading:

- Kuhn, Thomas. *The Structure of Scientific Revolutions* (3rd ed). Chicago: University of Chicago Press, 1996 (1962).
- Latour, Bruno and Woolgar, Steve. *Laboratory Life: The Social Construction of Scientific Facts*. Princeton: Princeton University Press, 1986.
- Shapin, Steve. *The Social History of Truth: Civility and Science in 17th-Century England*. Chicago: University of Chicago Press, 1995.
- Traweek, Sharon. *Beamtimes and Lifetimes: The World of High Energy Physicists*. Cambridge: Harvard University Press, 1992.
- Watson, James. *The Double Helix*. NY: Mentor, 1969 (1968).