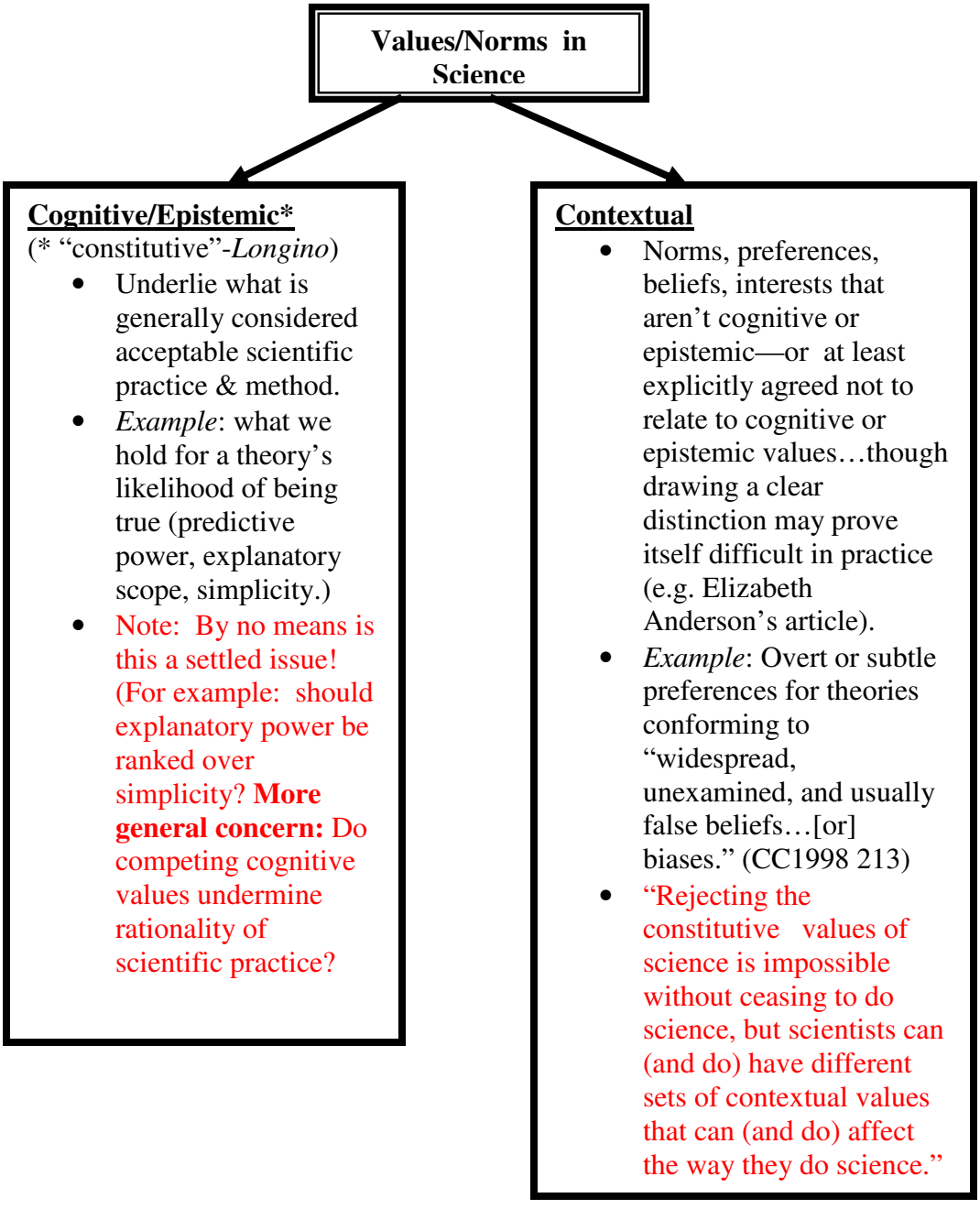
# ***Objectivity & Values in Science –pt.I: How value-laden are scientific theories and facts?***



- **(Recall Lecture 4, Sept. 11, 2007)** Thomas Kuhn's extremely influential *Structure of Scientific Revolutions* (1962) essentially overturned a central viewpoint undergirding science studies (history, philosophy, sociology,…) regarding the role of cognitive and contextual values. Prior to Kuhn, it was assumed that science was an essentially *accumulative* process…science essentially progresses via growth and accumulation of facts and theories producing (in the long run) increasing **knowledge** of the world of observable phenomena.[1]

> "Kuhn…insisted that there is **no set of universal rules for choosing between rival theories**, that **cognitive values are ultimately a matter of subjective preference that transcends rationality**, and that **nonrational psychological and social factors must play a vital role in determining which theory wins the allegiance of the scientific community**. Moreover, Kuhn continued to **reject scientific realism**, persisting in his view that **scientific theories should be regarded as instruments for solving puzzles**[2] rather than as literal descriptions (or would-be descriptions) of reality." (-**CC1998**, p. 84)

- Recall the 'Species' vs 'animal' scientific theory analogy distinguishing Kuhn from Popper (**Lecture 4**). Here we tighten this notion by using Kuhn's term: ***paradigm***. Paradigms should be understood as essentially overarching networks of ***framework-assumptions*** **and** ***norms*****, which comprise the cognitive values of a particular scientific theory.** (To sharpen the analogy: **Paradigms** function like the *broad species*, while theories are the *subspecies* thereon.[3])

"**[P]aradigms provide scientists not only with a *map* but also with some of the *directions essential for map-making*. In learning a paradigm the scientist acquires theory, methods, and standards together, usually in some inextricable mixture."** (*T. Kuhn,* "Nature and Necessity of Scientific Revolutions," **CC1998**, 100)

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[1] Note: This accumulation viewpoint was held by **realists** on the one extreme (those who hold that the primary aim of science is to give **true** descriptions and explanations of the world) as well as by **instrumentalists** (those who argue that the primary aim science is to function as a 'handmaiden for technology', insofar as enabling us to control our environment) on the other exteme, and in all positions in the middle. Recall Popper's falsificationism, for instance. **(Lecture 3, Sept. 7)** He was primarily interested in the *growth* (i.e. accumulation) of knowledge, which he thought was best exemplified by the what he considered was the *progress* of science, conceived of as paradigmatic of a **problem-solving activity**. (Where problems are precisely **defined** and attempted solution via precisely falsifiable/testable theories.)

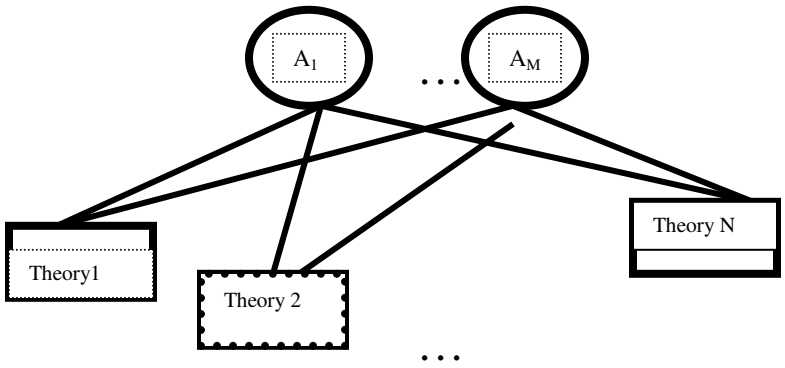
[2] Recall from **Lecture 4:** Kuhn writes: "It is important to notice that when I describe the scientist as a **puzzle-solver** and Sir Karl describes him as a **problem-solver** the similarity our terms disguises a fundamental divergence. Sir Karl writes…'[O]ur expectations, and thus our theories, may precede, historically, even our problems. *Yet science starts only with problems* Problems crop up…when our theories involve us in difficulties, in contradictions.' **I [on the other hand] use the term 'puzzle' in order to emphasize that the difficulties which *ordinarily* confront even the very best scientists are…challenges only to his ingenuity. *He* is in difficulty, not current theory. My point is almost the converse of Sir Karl's." CC1998** (n. 2, pp. 17-18)

[3] Or in data structures parlance: Paradigms are the 'root directories,' and theories are subdirectories, in terms of hierarchy of composition.

(…Recall 'punctuated equilibrium' remark, **Lecture 4**)

**"Therefore, when paradigms change, there are usually significant shifts in the criteria determining the legitimacy both of problems and of proposed solutions."**

**-***Kuhn* (ibid.)




- A simple schematic of a paradigm. The overarching network consists of *M* (trans-theoretic) **assumptions/cognitive values ("directions for map-making")** $A_1$, …, $A_M$ which constitute its *N* theories (subspecies)
- Influences: W. V. O Quine's 'Web of beliefs" (*"Two Dogmas of Empiricism"*) and Rudolf Carnap's "Linguistic frameworks."

- **Recall from Lecture 4:**

- **"Normal" Science versus Extraordinary (or Revolutionary Science)**[4]

"[W]hen engaged with a **normal** research problem, the scientist must *premise* current theory as the rules of his game. His [or her] object is to solve a puzzle, preferably one at which others have failed, and **current theory is required to define that puzzle** and to **guarantee** that that, given sufficient brilliance, it can be solved."

- **A 'puzzle' is *underwritten* by the theory**
- **A puzzle is characterized by the theory (including the norms of its possible successes of a solution)**
- **Puzzles, conversely do not undermine theories.**

[4] This distinction is one of Kuhn's most essential notions, as we'll see when we look at selections from his classic: *Structure of Scientific Revolutions* (1962), for instance.

***~Normal Science is the 'norm'~***

On the other hand, the 'testing' processes Karl Popper is fond to cite as being emblematic of the advancement of science, are rare and describe **revolutionary** or **extraordinary** science.

> "[T]he tests which Sir Karl emphasizes are those which were performed to explore the limitations of accepted or to subject a current theory to maximum strain…in using them to characterize scientific activity Sir Karl misses something terribly important about them. **Episodes like these are very rare in the development of science.** When they occur, they are generally called forth either by a prior crises in the relevant field…or by the existence of a theory which competes with the existing canons of research…**'[E]xtraodrinary research' [is] an enterprise in which scientists do display very many of the characteristics Sir Karl emphasizes, but one which…has arisen only intermittently and under quite special circumstances…**"
>
> (-ibid., **CC 1998**, p. 13)

***~ 'Revolutionary' Science is the 'exception'~***

**Furthermore:**

"[T]hough testing of basic commitments occurs only in extraordinary science, **it is normal science that discloses both the points to test and the manner of testing."**

(-ibid., **CC 1998**, p. 14)

"[I]t is for the normal, not the extraordinary practice of science that professionals are trained."

(-ibid., **CC 1998**, p. 14)

- **Kuhn's *political analogy***

1. "In both political and scientific the sense of malfunction that can lead to **crisis** is prerequisite to revolution." (-*T. Kuhn,* **CC1998,** 86)
2. "Political revolutions aim to change political institutions in ways that those institutions themselves prohibit…**in the interim, society is not fully governed by institutions at all…**as the crisis deepens, many…commit themselves to some concrete proposal for the reconstruction of [the] society in a new institutional framework. At that point the society is divided into competing camps or parties, one seeking to defend the old

institutional constellation, the others seeking institute some new one. And, once that polarization has occurred, *political recourse fails.* Because…they acknowledge no supra-institutional framework for the adjudication of revolutionary difference, the parties to a revolutionary conflict must finally resort to techniques of mass persuasion, often including force." (-*T. Kuhn,* **CC1998,** 87)

**KUHN'S THESIS:**

**The evolution of science exhibits some "very similar" characteristics (regardless of the scientific specialty or sub-specialty) during periods of paradigm-change. "Like the choice between competing political institutions, that between competing paradigms proves to be a choice between incompatible modes of community life…*the choice is not and cannot be determined merely by the evaluative procedures characteristic of normal science, for these depend in part upon a particular paradigm, and that paradigm is at issue.* When paradigms enter, as they must, into a debate abour paradigm choice, their role is necessarily circular...The resulting circularity does not, of course, make the argument wrong…[however] the status of the circular argument is only that of persuasion. It cannot be made logically or even probabilistically compelling for those who refuse to step into the circle."**

(-*T. Kuhn,* **CC1998,** 88)

- The logic of scientific knowledge does not provide the reasons for a community to assimilate new phenomena, develop a new scientific theory, or (much less so!) demand the overthrow of a paradigm. (89)

- Science *could* have developed in a more cumulative fashion (by the same token, novelty need not necessarily prove paradigm-challenging…note example of 'energy-conservation' "theory"[5] subsuming many branches of science and subspecialties. Nevertheless, "**cumulative acquisition of unanticipated novelties proves to be an almost non-existent exception to the rule of scientific development.**" (89) (??? Isn't science in the *business* of seeking novel facts about the world and generating novel approaches to understanding it?)

Well…, *no* (for science most of the time, according to Kuhn). Why? Because

- During periods of normal science, such novelty is subverted because:

"**[C]umulative acquisition of novelty is in fact improbable in principle [because] [n]ormal research, which *is* cumulative, owes its success to the**

[5] It may seem odd to cast what appears to be a general *law* in such terms, but Kuhn, here is speaking *historically.* It wasn't until the late 18th and early 19th centuries that the concept of 'energy' was rendered precise in physics.

**ability of scientists regularly to select problems that can be solved with conceptual and instrumental techniques close enough to those already in existence.** (That is why an excessive concern with useful problems, regardless of their relation to existing knowledge and technique, can so easily inhibit scientific development….**Unanticipated novelty…can emerge only to the extent that [the scientist's] anticipations about nature and his [or her] instruments prove wrong.[6]"** (89-90)

Three kinds of phenomena that *could* evince development of new theories:

1. Phenomena **already well-explained by extant paradigms.** (**Pragmatically,** No incentive to develop new theories accounting for such phenomena… "if it ain't broke, don't fix it.") *Example:* What would be the point of developing a new theory for radioactive decay ('scientific' creationist paradigm notwithstanding). Quantum mechanics and the modern physical paradigm in general (atomic physics, nuclear physics, etc. provide good explanations and accounts!) More importantly (**epistemic)** "nature provides no ground for discrimination." (90)
2. Phenomena accounted for by paradigm, but whose details require further theoretical elaboration for their 'precisification.' (*Example:* The complex braid-like structure of Saturn's rings are *in principle* underwritten by the celestial mechanics paradigm, but require much in the way of non-linear dynamical theories to account for the details of their complex structure.)
3. **Anomalies**. Their "characteristic feature is their stubborn refusal to be assimilated to existing paradigms. This type alone gives rise to new theories. Paradigms provide all phenomena except anomalies with a theory-determined place in the scientist's field of vision." (90)

**Example:**

*Energy conservation emerged after the crisis period of Newtonian vs. caloric fluid paradigms regarding phenomena of heat-flow. The heat engine (converting heat to work) represented an anomalous phenomenon to the caloric fluid paradigm, since the notion was heat was a 'conservative' fluid.*

**Paradigm Incompatibility/ Incommensurability**

1. To answer the charge that the old theory exists 'alive and well' as a special case of the newer theory: *Even when a simple quantitative reduction is set in place (i.e. deriving Newtonian gravitaitonal formulae from general relativistic formulae in the appropriate special circumstances and limits)* ***the fact remains that the very terms themselves mean different things in the different paradigms!*** **(For**

[6] This is precisely what Popper argues should be desirable situation. Kuhn reminds us however, that such situations are rather exceptional.

**example, in Newtonian theory, 'mass' is something that is conserved. In Special Relativity, 'mass' is something that inter-convertible with energy.) (92-94)**

2. Moreover, applying this 'old-theory-is-arrived-at-under-suitable-conditions-by new theory' is a slippery-slope maneuver. *Any* theory (no matter how wrong, albeit recognized in hindsight as glaringly wrong) can be 'established under suitable conditions' depending on how one hedges the latter**. "Some variant of this argument is quite sufficient to make any theory ever used by a significant group of competent scientists immune to attack." (92)**

**"**If existing theory binds the scientist only with respect to existing applications, then there can be no surprises, anomalies, or crises. But these are just signposts that point the way to extraordinary science. If positivistic[7] restrictions on the range of a theory's legitimate applicability are taken literally, the mechanism that tells the scientific community what problems may lead to fundamental change must cease to function**. And when that occurs, the community will inevitably return to something like its pre-paradigm state, a condition in which all members practice science but in which their gross product scarcely resembles science at all."** (93)

**"Let us therefore take it for granted that the differences between successive paradigms are both necessary and irreconcilable." (94)**

**Example:** ***Transition from Aristotelean/Scholastic paradigm to Newtonian paradigm (late 17th century)***

"Newton's three laws of motion are less a product of novel experiments than of the attempt to reinterpret well-known observations in terms of the motions and interactions of primary neutral corpuscles." (96)

| Scholastic Paradigm | Newtonian Paradigm |
|---|---|
| Nature has purpose, mediated by *final causes*/ objects have essences, properties (which aside from shape, motion, size, position [i.e. the *primary qualities* – Locke] were dismissed as 'occult' in the Newtonian paradigm. | Nature is a mechanism, constituted by *efficient causes*/ objects have fundamentally shape, motion, size, position [i.e. the *primary qualities* – Locke] . Other qualities, properties (taste, color, sound, etc.) are considered *secondary*, i.e. dependent on the interaction with the senses of the agent. |
| "Opium has dormative power" | "Opium 'particles' are round, which 'massage' the nerves." |

[7] A tradition we'll examine in greater detail in this course. Positivists argued that a scientific theory's primary epistemic value lies in its *verifiability. Logical positivists* tried to show that all significant scientific terms are in principle reducible to some observation-based vocabulary.

- **Gravity's (seeming) action-at-a-distance anomalous phenomenon with respect to local contact mechanisms**

**Other Examples:**

- ***Phlogiston → Lavoisier***

**Lavoisier paradigm did away with many explanatory devices of chemical principles used by the Phlogiston paradigm-adherents. "[However] [d]uring much of the nineteenth century failure to explain the qualities of components was no indictment of a chemical theory." (98)**

- ***Maxwell → Einstein***

**Search for a mechanical medium ('aether') supporting propagation of EM waves, even though nothing per se in Mazwell's formulation would seem to require it. Only in the case of the Special Relativistic paradigm does it make sense to speak of a 'displacement current' (for instance) not 'displacing' anything!**

**Questions/Problems:**

- **Kuhn seems to resort to an 'all-or-nothing' position when assessing his Incommensurability thesis (that paradigms 'talk past each other' (100).) Is there no common semantic ground?**
- **(Recall Laudan Lecture 4) are there any external criteria of rationality guiding paradigm-change, (assuming this characterizes the evolution of science?)**