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Kuhn & Boyd, An Account of Science

In 1962, Thomas Kuhn developed his most influential work *The Structure of Scientific Revolutions* which presented his novel, yet at the time radical views on the development of science as a cumulative process, observation, and scientific methodology. The ideas brought forth by Kuhn's work significantly conflicted with more traditional views held by the scientific community. As a result, his publication threw the scientific and philosophical communities into disarray. The traditional views that Kuhn clashed with held the idea that observation provided science with a theory-neutral medium in order to evaluate the merit of scientific theories. Even though scientists who held conflicting ideas could still disagree on how to interpret the results of an observation, they could still agree on the content of the observation itself. This provided a neutral, objective way of deciding between competing theories. Related to this, traditional views on scientific methodology held that there was a set of objective methodological rules which science could follow which was transcendent of any particular theory. When this scientific method was applied correctly this would dictate which theories should be accepted. When these views are taken together, it seems hard to deny that science has a cumulative progression. Science gradually gathers truths about nature with later theories carrying over the empirical conclusions made by prior ones and adding to it so that science seems to progress continuously towards the truth of our world. Kuhn denies all of this.

On the front of observation, Kuhn explicitly denies its functionality as a theory-neutral activity. As Kuhn describes it, scientists who are trained in different paradigms do not just interpret observations differently, they quite literally see different things. He uses several examples such as Priestley and Lavoisier observing the same experiment and seeing dephlogistication vs. oxidation. "Lavoisier, we said,

saw oxygen where Priestley had seen dephlogisticated air and where others had seen nothing at all...Lavoisier worked in a different world” (Kuhn, Ch.X pg. 134). When looking at the exact same thing, the two chemists did not just see different interpretations of the same thing, Lavoisier could not see dephlogistication in place of oxidation because the two concepts have distinctly different definitions of what the phenomena are observed as. Kuhn draws from this that what scientists observe are entirely shaped by a scientist’s paradigm because that paradigm lays the foundation for how observations should not just be interpreted, but viewed at face value. Kuhn concedes the idea of actual sense data being neutral but he argues that even in light of this, observations in order to be shared with others need to be communicated through language. And that language will never be neutral, everything must be described through language which has been precisely shaped by the current paradigm and relies on background assumptions supported by the paradigm (Kuhn, Ch.X pg.140-141).

Kuhn extends his same thoughts on observation being theory-laden to scientific methodology. He argues that there is no theory-neutral framework for theory choice. The standards which scientists use to distinguish what counts as a legitimate problem, a properly designed experiment, an acceptable solution, what data is relevant to collect, etc. are all shaped by the paradigm those scientists inhabit. The paradigm is not just foundational theories, it is also defined by adherence to a set of models for how science should be practiced. Only problems whose solutions can be defined by adherence to the current paradigm are actually pursued by scientists, other endeavors are considered a waste of time (Kuhn Ch. IV pg. 66-68). Therefore, scientists practicing in different paradigms will disagree not only about what they are seeing and which is true, but about how the truth should be discovered and what even counts as a real solution. The theory-ladenness of scientific practice in these respects is why Kuhn concludes that there is no neutral, objective way to draw conclusions from experiments and select theories.

What Kuhn concludes from his two theses on observation and methodology is incommensurability between paradigms. If observation and methodology are driven entirely by paradigm assumptions, then competing paradigms cannot be compared on a neutral basis and neither can

communication of concepts between paradigms be facilitated. With the theory-ladenness of observation and methodology, there is no description of observations or process of methodology that can serve as a medium to objectively evaluate the projectibility and truth of theories. Additionally, the cumulative progression of scientific truths cannot be postulated because of the—at the most defensible level—semantic incompatibility of definitions of concepts and observation across paradigms. What counts as a progression, a solution to a problem in phlogiston theory, is incomprehensible to a scientist in the modern paradigm which believes in oxygen. The cumulative progression of science fails because in scientific revolutions, questions central to the old paradigm become unaskable, phenomena it explains become invisible or peripheral, and terms shift their meaning (Kuhn, Ch.X pg. 122-124).

Another implication of this is that we do not have a paradigm-neutral way of assessing whether or not science is steadily approaching a true description of an independent reality. We can say that later paradigms solve more puzzles than earlier ones, or that they resolve the anomalies of a prior paradigm, but we cannot say on any rational basis that they are closer to an independent truth about nature because of a lack of neutral criterion needed to evaluate that progression (Kuhn, Ch.XIII pg. 175-177). Instead, Kuhn proposes a view of scientific progress as one that does not progress forward towards some objective truth of the world, but as an evolutionary process that develops from paradigm-to-paradigm. Kuhn describes it as “a process whose successive stages are characterized by an increasingly detailed and refined understanding of nature. But nothing that has been or will be said makes it a process of evolution toward anything” (Kuhn, Ch.XIII pg. 177).

Richard Boyd was another individual in the philosophical debate of the mechanisms of science, he developed an essay titled *On the Current Status of Scientific Realism* which developed a multifaceted defense for the scientific realist. The scientific realist, in Boyd’s definition, believes in four main premises: 1) Theoretical terms in scientific theories (unobservables) actually refer to real things in the world and are not just pragmatic predictability frameworks for observable phenomenon, 2) Scientific theories are confirmable and able to be supported through standard methodological criteria as being approximately

true, 3) Science does have cumulative progress in that each successive theory is more approximately true about both observable and unobservable phenomena, and 4) There is an independent truth which operates separately from our theoretical perceptions that scientific theories are partially describing (Boyd, pg. 1). In many ways, Boyd's position in his essay actually does not conflict with the ideas postulated in Kuhn's work; in fact, he largely adopts Kuhn's framework of theory-ladenness in observation and scientific methodology. He concedes that observation is shaped by the current paradigm—theory-laden—and that scientific methodology itself is thoroughly shaped by the foundational theoretical commitments that are relevant to the current scientific tradition. Judgments about which hypotheses are worth testing, which experimental designs are appropriate, what instrumentation is reliable, which generalizations are projectable, etc. are all determined based on paradigm-dependent assumptions (Boyd, pg. 19). However, Boyd comes to the conclusion that realist ideas are not disputed by accepting the theory-ladenness of scientific activity and that it actually provides the most epistemological argument for scientific realism (Boyd, pg. 13).

Boyd's central argument for realism is an abductive one, an inference to the best explanation. Despite scientific methodology's dependence on theories, it is exceptionally reliable at producing precise novel predictions which survive empirical scrutiny and support technological advancement (That technological advancement can be referred to as "instrumental success" as used by Boyd in his essay). But if scientific methodology is so reliant on arbitrary background assumptions about the current paradigm, how can science be so reliable unless the theories were at least approximately true and their central terms genuinely referred to real features of the world? This is the point Boyd makes. (Boyd, pg. 23) Without conceding Boyd's point, anti-realists are put in an awkward position to admit that the reliability of theory-dependent methods becomes a kind of repeated miracle. Boyd argues that the approximate truth premise must be the only explanation that does not leave methodological success mysterious. Boyd reinforces his point by covering how projectability works in science. Any inductive inferences made about either observed or unobserved phenomena which are best supported by the

framework of paradigm are the ones made projectible. Therefore if those theory-dependent projectability judgments are systematically reliable then the theories guiding those judgments must be tracking something real (Boyd, pg. 41). Furthermore, if one wants to deny the epistemological validity of making inductive inferences (such as the empiricist), then they must reject the instrumental reliability of scientific methodology because that itself is an inductive generalization. Denying the instrumental reliability of scientific methodology is absurd, it is something that we can take an objective measure of (Boyd, pg. 33-34).

Another idea that Boyd presses is that Kuhn's observations conflict much more heavily with an empiricist's line of reasoning than against realism. Empiricism requires that observation and scientific methodology be a neutral medium to serve as a rational means of deciding projectibility among competing theories. If we accept Kuhn's standpoint then the empiricist is in serious incongruency. However, realism still remains a strongly viable candidate. Realism has a neutral-independent account of why theory-laden methodology works, namely the approximate truth claim. Thus Boyd interprets Kuhn's view as not undermining that science is tracking reality. What Boyd really denies of Kuhn is his thesis of strong incommensurability. Boyd claims that even when scientists in separate paradigms have different theoretical terms for certain unobservable/observable phenomena, their terms can still refer to the same things that are real. Theoretical terms should not be evaluated by their paradigmatic definitions, instead by their causal relation to phenomena in the real world (Boyd, pg. 24). Otherwise, that strong incommensurability works against the strongly demonstrated instrumental progression of science; if every successive theory had to start from zero, then it would be miraculous that the level of instrumental reliability displayed in our world is present. Therefore successive theories can be genuinely compared as better or worse approximations to the truth and that science can be tracked as a cumulative progress where scientists of successive paradigms build continually better approximations of what a theoretical term is actually referring to (Boyd, pg. 21-22).

When it comes to evaluating who we should side with about science, granted that Kuhn's views on observation and scientific methodology are an accurate description of how science actually functions, I believe that Boyd provides a more cogent conclusion. Boyd's strongest argument is the decisive issue of instrumental success for those who hold a strict Kuhnian view of incommensurability and cumulative progress in science. The semantic incommensurability between theoretical terms is hard to refute. Newtonian mass and Einstein's relativistic mass cannot be used interchangeably because they explicitly refer to different definitions and have distinct connections built around other paradigm-specific concepts. Yet it is well-documented that science continually demonstrates its adequacy in producing increasing predictive precision of phenomena and greater human capacity to manipulate the world with increasing reliability and scale through technological advancements. This pattern of increasing instrumental reliability is something which follows through both the process of normal science and revolutions and is difficult to be reliably explained if one holds a strong commitment to absolute incommensurability. Newton's theories enabled real prediction and manipulation; Einstein's relativity preserved that success and extended it. Phlogiston theory's instrumental successes were accumulated and exceeded by oxygen theory. If paradigms were genuinely sealed from one another and causal meaning shifted drastically through revolutions, the cumulative instrumental and predictive success of science would be unexplainable except by miracles. The bar of instrumental success carries forward even when concepts do not, which leads to the inductive conclusion that each successive theory is referring to something real at least to an approximately true level. This is the core for Boyd's criticism of Kuhn's conclusions about incommensurability and the cumulative progress of science. It is important to note that Boyd does not reject incommensurability but simply dampens its range of applicability to a purely semantic level.

One might reject this conclusion through historical examples; There have been cases where theories across paradigms have not been referring in accordance with our current paradigm. For example: phlogiston and oxygen. In the case of Newton's mass and Einstein's mass it is simpler to argue that both paradigms were causally tracking the same real property but with varying accuracy. However, in the case

of phlogiston and oxygen, phlogiston was not just a less accurate version of oxygen, it was the wrong substance with a different causal relationship than oxygen. However, Boyd's position with his epistemic access theory does not guarantee every past theory as referring, only that a theoretical term refers when causal interactions between the world and scientific practice make it the case that what is said about the term is reliably regulated, over time, by the real properties of some entity (Boyd, pg. 24-25). So when phlogiston theory is evaluated by modern scientists through the oxygen paradigm's reliability framework, we cannot say that phlogiston was a theory that referred. What accumulates as scientific progress in this scenario of a non-referring theory is the experimental practice and data. Priestley's experimental procedures for phlogiston theory really were causally connected to oxygen theory even if that data was interpreted differently during the phlogiston paradigm. When the paradigm shifted to oxygen, the procedures developed by Priestley still carried forward in a sense (Boyd, pg. 25). Additionally, it is justifiable to use our current paradigmatic lens to evaluate the reliability of a past theory. Even if using the reliability framework of the past theory's paradigm ends up succeeding in counting a theory as referring, we can still trust the judgement of our current paradigm because of the evidential increase in instrumental success of the current paradigm. It is defensible that our current assessment of reliability of a theory is better than a prior assessment from a different paradigm, even if circular, because we have proven that the current paradigm has demonstrated greater instrumental success which can be measured objectively. With this, I can accept Boyd's dampening on incommensurability, his view on cumulative progression, and side with him on science.