DEFENDING IAN HACKING'S ENTITY REALISM AGAINST THE ONSLAUGHT OF WILLIAM J. MCKINNEY

CHRISTIAN C. EMEDOLU, PhD.

DEPARTMENT OF PHILOSOPHY

UNIVERSITY OF PORT HARCOURT, CHOBA, PORT HARCOURT, NIGERIA

Abstract

Ian Hacking presents very extensive discussions of his experimental realism in *Representing and Intervening* (1983). Ever since that time critics have hounded his view, offering one damaging remark or another. Most of these damaging remarks have been responded to by Hacking and his allies. In this paper I take it as a task to revisit and react to the criticism leveled against Hacking by William J. McKinney. Here, I argue that Mckinney's presentation of anomalous water experiment does not prove what he thinks it proves. It does not in any way undermine or bring novelty to the distinction between "experimenting with" and "experimenting on". McKinney's argument that it was later realized by the scientific community that the anomalous water produced was not as a result of polymerization – i.e., that is not "polywater" – does not rob whatever was produced its "entityness". The putative entity has its characteristics and independent existence. The only thing it lacks is utilitarian value which can be socially, if not ontologically given. Therefore, Mckinney's argument proves nothing against Hacking's well-fortified experimental realism discourse.

Keywords: Hacking, McKinney, Experimental Realism, Polywater, Anomalous water.

Introduction

Right from Greek philosophical antiquity, arguments have gone, back and forth, concerning the existence or non-existence of both observable and unobservable entities/objects/denizens. Agnostics and skeptics of sorts have all taken part in the debate. This debate has metamorphosed in our time into what is call realism and antirealism debate. Whereas the scientific realist has the inclination to believe that what a scientific theory postulates about reality is either *true* or *false* (or simply that the *entity* talked about in a theory is *real*), the antirealist is skeptical about it and sometimes bluntly denies any such claim.

In his wake, Ian Hacking moves the argument away from theorization and anchors it on experimentation. He re-examines the techniques of skillful validation of experimental results. In practical terms, he does not deny the upsurge of experimental or instrumental artifacts, but urges that most of these artifacts are gradually weeded out in the process of compulsory replication of the result of any given scientific experiment. He *calls* this process of weeding-out *debugging* or *removal of "noise"* from the instrument.

Hacking extensively argues that, experimental determinations (results) or observational resolutions (reports) depict something *real*, because actual entities are being *detected* (via some causal affordances) and *manipulated* to yield some authentic results. According to Hacking, insofar as scientists have intuited a way of using electrons to study other parts of nature (as in quark hunting experiments), then these electrons are very real. Put more directly, the electrons are sprayed with standard emitters on the niobium ball to decrease charges, while positrons are sprayed to increase charges. If one can spray or manipulate these two unobservable particles, then they exist. This ultimately shows that in scientific experiment we interact with reality or transparent nature, not mere artifacts as some of the positivists (in their various strands), the radicals, and the social constructivists tend to presume.

Hacking strongly believes that anti-realism loses foot-hold in the face of entity/experimental realism. Indeed, Hacking considers it as his dessert to accept and believe only those theoretical entities which scientists have been

able to discover and manipulate, using experimental instruments. In Hacking's overall view, sense-extending instruments of varying sophistications should form part of our cognitive tools. This implies, for Hacking, that experimental manipulations or the deliverances of scientific instruments should constitute a genuine part of our epistemological experience of the world.

Having said all this, Hacking's discussions of experimental/entity realism have extensively been criticized by several scholars in the field of philosophy of science. Whereas some such criticisms are worth the efforts, others are baseless. Yet some other ones miss the mark entirely with respect to the central thrust of Hacking's doctrine on entity realism. This missing of the mark is what particularly draws our attention to William J. McKinney, who in his haste to stricture Hacking lost track of the mainline argument.

Now, I shall begin with a consideration of how the question of existence of some unobservable entities that have gone beyond the level of mere hypothetical entities sounds in the ears of practicing scientists. I will then look critically at Mckinney's remarks on Hacking's experimental realism with his scenic painting of the anomalous water experimental episodes. Lastly, the conclusion will follow.

Non-Trifling question of Existence of Unobservable Entities

The question of existence of unobservable entities in science seems to be unending with the massive rise of antirealists of varied persuasions in recent times. Now, what are we talking about? We hear a medical expert working in TB space shouting: "Tuberculosis is defying all means to survive. This is a wake-up call for everyone. All hands must be on deck in this fight of ending the TB epidemic. Tuberculosis has no boundaries, it is in the air and once you are exposed to infectious dose, depending on your immune system and the type of strain involved, the disease manifests. Prevention is better than cure. Early detection and treatment is key to TB control. As individuals, all activities that can predispose us must not be allowed to see the light of day – e.g., smoking, exposure to dangerous fumes and chemicals, poor health seeking behavior, poverty, and much else. People in the health sector must ensure that all patients comply and are given adequate and appropriate treatment to avoid drug resistant TB. There should be adequate regulation on the rational use of first and second line anti-TB drugs. They should not be sold over the counter or in the open market. A huge amount of work awaits the scientists. Development of vaccines and new drugs that have minimal side effects will be a welcome achievement. In fact, there is need for more stringent monitoring of the tuberculosis situation to prevent further acquisition of resistant genes by the organism and hence the development of resistance that is beyond what humans can manage".

To come to terms with reality: Is this a false alarm or a genuine concern over what a deadly microorganism is doing to mankind? There is clamor all over the world each time various (viral/non-viral) pandemics ravage the world. Are scientists mere rumor mongers? Is it the case that *Mycobacterium tuberculosis* has no actual existence and cannot be the causative agent for the ailment called tuberculosis? What about the structural manifestations that accompany different techniques used in isolating a particular unicellular organism considered to be responsible for a certain disease condition? Are governments the world over wasting their resources underwriting scientific research, building eponymous scientific instruments for experimental purposes? What is the case if we are not fighting real-time situations and conditions? How can all this be directed to a mere phantasmagoric end?

Right from the first half of the 20th Century scientists have started talking in terms of Matter Microscopes. They are sophisticated machines (atom smashers) like the one at Stanford Linear Accelerator Center (SLAC) that is 2-mile-long. Now, the recent 17-Mile-long Large Hadrons

Collider is yet another marvel to behold. Others beyond 17 miles are being developed in the United States of America. Some such technological or engineering marvel can also be seen very close to Geneva, at the international (EUROPEAN) laboratory for nuclear research (CERN), where almost the entire European nations collectively made an enormous financial investment. Today, they are everywhere, in Russia, China, Japan, and some other places. With these atom smashers or matter microscopes the scientists strongly believe that they have bypassed the molecular, atomic, and nucleic levels of material things. Indeed they have headed deeply into the nucleic hadrons and the quarks. The hadrons posed themselves as a riddle, resolving themselves into two broad families, namely *baryons* (proton and neutron, etc.) and *mesons* (pi-meson, rho-mesons etc.). Murray Gell-Man and Yuval Needman in 1961 noticed some kind of patterns in the classified hadrons and came up with the celebrated "eightfold way". Pictures of the tracks left by these hadrons could be captured through the bubble chambers and the photographic emulsions. The spin, isotopic strangeness, and electric charge qualities of these hadrons eventually led Gell-Man to announce the existence of the quarks as the most basic building block of mater. In other words, hadrons are the molecules of quarks in the same way two atoms of hydrogen and one atom of oxygen form water molecule. Of course, Gell-Man was rewarded with a Nobel Prize in 1969.

Now, Hacking agrees that experimental research is no child's play. Sophisticated scientific instruments are delivered to us via modern technology with which experimenters interact with theoretical or unobservable entities. Hacking argues that sometimes experimenters go beyond merely "experimenting on" a particular entity to a point where they "experiment with" the entity, having gained some causal knowledge about the entity and its effects on a given scientific instrument. At the level of "experimenting with" an entity, Hacking maintains that the scientist has reached the threshold of manipulating the entity. Having reached this threshold, Hacking argues that the scientist may beat his chest and sing his credo on the existence such an entity. This, surely, does not mean that manipulability is the sole guarantor of existence. It is obvious that one does not need to manipulate every entity in order to ascertain its existence.

Nevertheless, Hacking's orientation to entity realism is roundly packaged by W. H. Newton-Smith in the following way:

> *Recently, however, there have been entity-realists who are not truth-realists. These realists (notably Cartwright and Hacking) hold that we are justified in believing in the existence of theoretical entities only when we are in a position to use these entities to produce effects. For example, electrons exist for we can use them to produce scintillations. Unless we could use quarks to do things, discourse about them would not be construed realistically by the entity-realist. On this account, we introduce terms like 'quark' into our theories without thereby necessarily taking on any commitment to existence of quarks. The commitment to existence comes only when we talk of the items in question as things which can be used to produce certain effects (1996, p. 183).*

In fairness to Hacking, Newton-Smith critically examined the "ingenious experiment started by LaRue, Fairbank and Hebard at Stanford" in the very process of "hunting for 'free' quarks using Millikan's basic idea". But at bottom, Hacking's conclusion on the issue reads: "Nothing in theory suggests that quarks have independent existence" (1983, p. 23). In fact, Hacking maintains this attitude toward quarks precisely because these entities have not been deployed experimentally to serve some other purposes. As

it stands, James Trefil shares the same disposition toward the experimental result achieved by the above quark hunters when he writes:

> *In 1977 scientists working in the laboratory of William Fairbank at Stanford University reported that they had seen fractionally charged matter in an experiment. This is the only claim for quark discovery that has not been largely rejected by the scientific community, but it would be wrong to conclude from this that the claim is now accepted. The present attitude is one of 'wait and see'. If others can reproduce the Stanford result, it will be acknowledged as the first discovery of quark. If it cannot be reproduced, it will probably not gain widespread acceptance (1986, pp. 168-169).*

This shows that Hacking's skepticism over quarks was a general disposition even years after the Stanford scientists did their best in trying to isolate it. For Hacking, therefore, the existence of any unobservable entity is completely proven when some such entity can be experimentally manipulated and used to study other parts or aspects of Nature. The un-strangeness of Hacking's doubt is equally supported by the fact that, "…in Einstein's day some physicists still debated the existence of atoms. For over two millennia people had suspected the existence of atoms, but there had never been a way of proving their existence" (Pagels, 1982, p. 10). Nowadays, with the discovery of the Higgs particle and Higgs boson in July, 2012, all this historic doubt has passed into oblivion, especially, for the working scientist.

Hacking argues that, in the process of hunting or investigating an entity experimenters use various physical techniques in weeding out instrumental artifacts or differentiating transparent reality from artifactual experimental conditions. According to Hacking, making this sort of distinction requires the observant eye of an accomplished experimenter. In spite of the fact that some philosophers of science make much fuss about artifacts, it is very obvious that some such artifacts are regular camp fellows in any genuine experimental scientific situation – a condition every good instructor must have to pass on or hand-out to would-be scientists. I learnt in my early days of training as young scientists that some artifactual conditions and instrumental errors cannot be mitigated or completely weeded out, so they are somewhat factored into the results of scientific experiment. On this particular issue of weeding out, debugging or reducing noise, Hacking's has this to say:

> *Short descriptions make it all sound too easy, so let us pause to reflect on debugging. Many of the bugs are never understood. They are eliminated by trial and error. Let us illustrate three different kinds: (1) the essential technical limitations that in the end have to be factored into the analysis of error; (2) simpler mechanical defects you never think of until they are forced on you; (3) hunches about what might go wrong (1983, p. 269).*

Scientists are often conscious of the fact, right from the wake of modernity, that whatever hypothetical entity they are postulating must be bereft of occult features. An ideal hypothetical entity in science must have a causal way of interacting with scientific instruments. Isaac Newton fought with the Cartesians over René Descartes' Vortex Hypothesis. Gottfried von Leibniz, in turn, criticized Newton's ideas of "Gravity" and "Absolute Space" (i.e., bucket theory of space) as having occult features that are not amenable to empirical testability. Fortunately, in the late 1960s and early 1970s, it was alleged that Joseph Weber detected gravitational radiation or gravity waves – the last confirmation was done in 2016 with a very large

interferometer. Scientists have long hypothesized gravitons as bearers of gravitational force the same way they recognized photons as carriers of electromagnetic force and nuclear bosons as harbingers of the strong and weak forces. Incidentally, "space" is still in the philosophical battle field after the in-roads made by Albert Einstein. Nobody as yet has concluded on dimensions of space – whether there 3, 9, 20, 25, etc., dimensions to it.

Every now and then astro-physicists are treated to the diet of discovery of giant Black Holes in one galaxy or another. Uriah Chinwa wrote on the phenomenon of the Black Hole. Along the line of discussion, Chinwa points out that the virtual particles detected in the so-called Black Holes cannot be seen or "observed directly, but they do indeed produce effects which can be and have been observed. In this way therefore, VIRTUAL PARTICLES can be said to be indirectly observable" (2003, p. 77). Tying the virtual particle (as a binding force of the atomic nucleus) to uncertainty principle, Trefil, for his part, unfolds: "One way of visualizing the appearance of virtual particle is to think of it as 'sneaking out' while no one is looking" (1986, p. 50). Ultimately, Trefil admits this much: "I should point out that modern nuclear physics experiments provide strong (albeit indirect) evidence for the existence of virtual particles" (1986, p. 52). All this eventually shows that the question of existence of unobservable entities is very essential to the practice of science; little wonders philosophers of scientific experiment have, in recent times, engaged themselves in the great discussions of particle/wave existence.

Having seen the importance scientists attach to entities that get entangled (involved) or are produced in the process of experimentation, we think it is time to review or examine McKinney's thesis against Hacking's experimental realism.

Ad William J. McKinney

The fundamental goal here is to show that Mckinney's article, "Experimenting on and Experimenting with: Polywater and Experimental Realism," is based on a misplaced understanding of Hacking's position on manipulation of unobservable entities as proof of their existence. Mckinney's paper appears to be suffused with much demonization stratagems of the postmodernists, for it culls so many statements from Ian Hacking's *Representing and Intervening* (1983) and analyzes them in an out-of-context and off-putting manner. This arises from a misinterpretation of Hacking's mainline arguments. Mckinney observes that, "In *Representing and Intervening* [1983], Hacking concludes that scientists can assert the reality of theoretical entities based upon their abilities to manipulate them" (1991, p. 296). The point of Mckinney's argument, of course, is that "Manipulability, as defined by Hacking (1983) is not a necessary condition for reality" (1991, p. 306). Mckinney argues that, it is always "possible to be convinced of an entity's reality without meeting Hacking's criterion" (1991, p. 298). In other words, "determinations of realism can occur without Hacking's manipulability" (Mckinney, 1991, p. 299). Mckinney seems to have strengthened his charge against Hacking by now using the anomalous-water/polywater case, instantiating that, "The scientists involved in the dispute never resorted to Hacking's criterion of using well established causal properties of an entity to determine that entity's reality" (Mckinney, 1991, p. 305).

No doubt, all what Mckinney says in the foregoing paragraph are incontestable or brute facts. But, then, saying something that is even clear to a mere rustic is equivalent to saying nothing. Fortunately, Mckinney is gracious enough though to afford us the defence Hacking puts up against the onslaught of his critics in 1989, wherein hacking writes:

> *There might, however, be some other compelling argument about scientific realism for extragalactic entities…I did not say in my (1983) that an experimental argument is the only viable argument for scientific realism about*

> *unobservable entities. I said only that it is the most compelling one (qtd. in Mckinney, 1991, p. 298).*

Of course, the question is: If Mckinney knew that Hacking made this serious effort to exculpate himself from the blame of insinuating that manipulability is all that one requires to prove the existence of any entity, then why should Mckinney present it again as a faulty criterion in his strictures against Hacking's experimental realism? As is clear in the very words of Mckinney, "Manipulability, as defined by Hacking [1983], is not a necessary condition for reality" (Mckinney, 1991, p. 306). Indeed, it would be pretty difficult for one to believe that manipulability can serve as a necessary and sufficient condition for reality.

Perhaps Mckinney might have read the following popular quip from Hacking's *Representing* and *Intervening*: "Long-lived theoretical entities, which don't end up being manipulated, commonly turn out to have been wonderful mistakes" (Hacking, 1983, p. 275). Such a leading statement might have made Mckinney jump to conclusions. I do not think that this is the right approach to philosophical reasoning. Mckinney clearly fails to properly contextualize Hacking's statement. The case is that if Mckinney were, as a matter of methodological consideration, reviewing only Hacking's *Representing* and *Intervening*, he could be somewhat excused for wrongly interpreting Hacking's statement in the manner he did. I say wrongly, precisely because there are other counterbalancing statements in the Hackinian text which suggest that Hacking is not really arguing to the effect that manipulability is the only way to prove existence. But since Mckinney is aware of the fact that Hacking did clarify his actual position after the publication of *Representing* and *Intervening*, we think there is no urgent need to harp on such an issue again.

To all intents and purposes, Mckinney tells us again that his paper is an attempt to dispel "…the unfortunate confusion of two closely related concepts in experimental science: the ability to experiment on some entity and the ability to manipulate that entity" (1991, p. 295). Here, think that Mckinney's effort is not worth it. No doubt, he cites a passage from hacking which reads: "Experimenting on an entity does not commit you to believing that it exists. Only manipulating an entity, in order to experiment on something else, need do that" (Hacking, 1983, p. 263). This does not imply that Hacking forever speaks in terms of *experimenting on*; but he speaks largely in terms of *experimenting with* – by way of "…endless manipulations of the 'theoretical' (entities)" (1983, p. 24). In fact, Hacking specifically writes: "What convinced me of realism has nothing to do with quarks. It was the fact that by now there are standard emitters with which we can spray positrons and electrons – and that is precisely what we do with them" (1983, p. 24). Hacking is here saying that scientists can now use some home truths about electrons and positrons to study some other aspects of reality that are not yet clear to us. Whereas the experiment is *on* quacks, the entities being manipulated are positrons and electrons in the experimental design being described. As such, any critic bringing about this sort of confusion as to whether Hacking blurred the distinction between "experimenting on" and "experimenting with" is merely misleading the audience; for Hacking's analysis above does not suggest what Mckinney thinks.

Mckinney plods his weary way further by using the case study of anomalous water or polywater experiment. He tries to distinguish between anomalous water and polywater. According to Mckinney, "we must distinguish between two terms – 'anomalous water' and 'polywater'. 'Anomalous water' will refer to the actual material produced in the laboratory; 'polywater' will refer to the more widely accepted of the many attempts to embed this material in a new explanatory framework". In another circumstance, he says that "'polywater' was the name often applied to the pure substance obtained after the regular water was distilled off"

(1991, p. 299). But for the purposes of this paper, we wish to use both terms interchangeably.

Mckinney specifically deploys the case of polywater to show that, "it may be argued that Hacking's experimental realism does not adequately take into account the conceptual frameworks with which scientists judge whether theoretical entities are real or mere experimental artifact" (1991, p. 296). Epistemologically speaking, the anomalous water experiment was valid, even though the experimenters wrongly thought it was produced from "pure (ordinary) water alone". All its attributes could be measured, yet it is merely an artifact of scientific experiment.

> *…its physical properties were astounding. Deryagin's first finding was that the material exhibited a viscosity approximately fifteen times that of normal water. In addition, its thermal expansion was one and one-half times that of ordinary water (at 20-40^0 C). The material solidified at around –30^0 C, and boiled in the region of 250^0 C. Finally, it exhibited a density of 1.1-1.5 g/cm3 – significantly greater than that of water (Mckinney, 1991, p.300).*

At any rate, this inference from the polywater episode to the conceptual framework of judging the *reality* or *artificiality/artifactuality* of theoretical entities is baseless or irrelevant. I do not see the essence of Mckinney's argument here. An entity has been created in the laboratory, and so what? From his narration Mckinney shows that the whole episode of anomalous water investigation conforms to the "basic tenet of experimental science that any experiment must be capable of confirmation by a qualified independent observer" (Crosland 2011, p. 15). As such, it makes no real sense to say that, "…anomalous water was ultimately determined to be an artifact" (1991, p. 300). Even if a group of scientists cannot provide adequate conceptual framework for ascertaining the reality of the entity they are investigating, then, how is it the business of Hacking's? It is obvious that Hacking wrote articulately on aberrations, how such instrumental noise could be reduced or weeded out completely. Hacking argued that every attempt at repeating an experiment involves some level of improvement on what is done previously, which somewhat increases the validity of experimental results. Ultimately, Hacking discussed the important question of artifact and transparency, how different experimental techniques could be deployed to sieve out transparent reality from artifactual debris. Of course one reads from Mckinney that the scientists involved in the episodic event of the anomalous water experiment took all the precautionary measures that Hacking mentioned. They looked at their instruments and its capacity to provide a valid result. They also checked on the issue of contamination and changed the quality of the instrument. In fine, they adopted the standard procedure for doing gainful experimental research.

Following the singular example of anomalous water Mckinney presents, the truth of the matter is that artificial entities can be created at random in the laboratory. To be sure, these artificial entities that cannot be said to be of natural kind are pure artifacts; yet their ontological status can never be denied. Mckinney should not have wondered why the anomalous water had its peculiar features. To say that polywater is a combination of impurities (by way of contamination) makes no sense because more than 98% of the natural occurring waters are also laden with impurities. Moreover, Mckinney shows his ineptitude about experimental realism when he concludes:

> *From impetus physics to phlogiston and polywater, the history of science is the history of failed theoretical interpretations of often time perfectly valid experimental results. Reason for belief in the reality of theoretical entities are not*

> *iron-clad guarantees of ontological truth (1991, p. 306).*

Here, I must say that the intuition, or rather counter-intuition, that leads to any search for theoretical entity is often very sound and unquestionable. One may particularly argue for the existence of phlogiston by changing some modern scientific modalities. This may lead to an intricate argument that will clearly show the change of threshold that brought about the naming of oxygen as the performer of a key role formerly assigned to phlogiston in terms of oxidation, not calcinations or acidulation. Strictly speaking, with the correct shift of threshold and a state of the art experimental instrument the ontological truth behind phlogiston's existence may never be denied by any right thinking scientist. In 2012 the Cambridge Chair in the History and Philosophy of Science in his inaugural Lecture aptly demonstrated the facticity of existence of phlogiston as what we today call electron. The main problem we have is that of proper characterization of entities in terms of providing an everlasting or permanent stereotype for them. At some other points, too, these entities are abandoned merely because the scientific community feels it cannot make new headways with them. This often leads to change in the direction of research, which makes scholars like Mckinney feel that abandonment smacks of non-existence. There are several other intricacies, combinations, and directions involved in the history of scientific experimentation.

The fact remains that polywater was "experimented on"; for it "could be burned with a laser, melted and frozen. Investigators measured its dielectric constant, thermal conductivity, parallel conductance, boiling point, melting point, density and viscosity…" (Mckinney, 1991, p. 305). Now, I strongly think that, the reason why the so-called "polywater" or "anomalous water" was abandoned is because the Soviet Union experimental scientists could not assign or attach any tangible role or find some applications for it. Had it been any utility was found for it, say, in the pharmaceutical, agro-allied, or petro-chemical industries, a new song would have been intoned for it – in which case one would have been talking about "experimenting with" polywater. This surely provides reason that nullifies the following Mckinney's statement: "It is clear from the discussion above that many of the experimenters who studied anomalous water were convinced of polywater's reality. It should also be clear that in no sense could we say that they ever experimented with polywater" (1991, p. 303). What is in a name? The experimenters felt the anomalous water came as a result of polymerization of normal/natural water, therefore nothing prevents them from thinking they were handling polywater. Certainly, with hindsight, they would not feel that way after real conditions and status of the water have been ascertained. The clear fact is that the issue of polymerization would not have arisen if the scientific community had found a quick pragmatic role for the anomalous water.

Be that as it may, Mckinney seems not to understand what his language is actually doing when he writes: "The results of the polywater investigations were not artifactual (aberrant), and hence valid. Our best interpretation of the results, however, is that anomalous water is an artifact" (1991, p. 296). This sound, inevitably, like double-speaking to one who is very much engaged with ontological consideration or interpretation of experimental results. It is a well-known fact that some of the entities talked about today in the scientific community are created in the laboratory and can never be considered as natural kind entities.

The real Promethean experimenter is simply interested in knowing how this so-called artifactual or artificial entity could eventually be manipulated or used to some positive ends.

Thus far, the episodic or celebrated case of valid anomalous or polywater experiment does not really prove what Mckinney thinks it does. The validity of an experimental result is a distinct thing from its interpretation. To be sure, interpretation is at the level of theorization.

Mckinney seems to have understood this fact in a passage cited above: "From impetus physics to phlogiston and polywater, the history of science is the history of failed theoretical interpretations of often time's perfectly valid experimental results" (Mckinney, 1991, p. 306). But whether he understands it or not, experimental result has an independent life. Hacking amply demonstrated this in his *Representing and Intervening*, wherein he established the autonomy of scientific experiment from the angle of creation of phenomena or effects. Countless effects have been created in the long history of experimentation. The theoretician may intuit the existence of polymerized water and the experimenter may go about searching for it. Of course, there are certain conditions attached to what scientists designate as polymerization process. If the test is properly applied, then it will eventually be discovered that anomalous water is not polywater. Mckinney is right in insisting that, "the interpretation of these results was greatly mistaken". Hence, no one has any grouse with fact that "scientists are justified in changing their minds regarding the reality of theoretical entities" (Mckinney, 1991, p. 299). Yes, in the case narrated the entity was not "polywater", but it was "anomalous water". Much ado about nothing!

What simply happened in the case study is not just that contamination brought about anomalous water, but that the scientific community was unable to find any use for it. In the long history of science, we have noticed the emergence of certain unpredicted phenomena or accidental entities that later turned out to be useful to the world. Had such happened, the scientists would be singing the praise of polywater or anomalous water and Mckinney would not have cited it as a bad case. Meaningful and useful artifacts have most times appeared in laboratories in the pretty long history of experimental science. Natural occurring entities are not the only substances permitted to see the light of day in science. In the domain of experimental science, social constructivists do comfortably claim that there are no natural kinds.

Anomalous water was the entity created in the case study experiment and no one doubted it. As Mckinney puts it: "There was never a doubt that the production of anomalous water and the measurement of its physical properties were valid experimental results. We could easily produce a sample of it, given the proper equipment" (1991, p. 299). This clearly shows that the creation of a certain entity is not in question. Whether it was a creation arising from polymerization process or contamination is a different consideration that has little impact on experimental or entity realism. The failure to manipulate anomalous water or experiment with it is not something inherent in that entity; it has something to do with socio-economic need at that material point in time. It is clearly not impossible to experiment with anomalous water, even though its existence is not dependent on manipulability. Hacking's case is quite clear: An entity must exist before it can be manipulated. To say that manipulation is a sign or proof of existence does not entail that there cannot be existence without manipulation. This is a basic elementary logic that Mckinney failed to learn before jumping into arguments against Hacking.

Conclusion

I think this is the most genuine way of bringing Mckinney round. From all indications, one must have noticed in the body of the discussion that it is pretty difficult to assail Hacking's position on entity or experimental realism. To attempt to refute the ontological status of theoretical/unobservable entities is to labour in vain to push the earth away from your very feet. The moment critics began to realize this fact, they will equally know when to sheath their swords and channel their energy to something else.

Mckinney's discussions lacked substance. He ended up talking about the artifactual creation of anomalous water, which is a visible entity in its own right that did not go through what scientists regarded as a thoroughgoing polymerization process. Arguments about the creation of entities

in the laboratory have gone on within the circle of radical social constructivists, wherein Bruno Latour and Karina Knorr-Cetina pontificate. In 1983, for instance, Latour published an essay, entitled, "Give Me a Laboratory and I will raise the World" (Emedolu, 2014, pp. 106-112). Henk van Den Belt highlights that Latour insists that nowadays technoscience "is engaged in ceaseless proliferation of ever new entities, 'hybrids' or 'quasi-objects' or whatever those products may be called" (2003, p. 208). Of course, no one can deny the truth of this. The only thing that made the wrongly-dubbed "polywater" fade away is because no role was found for it in any chemical, pharmaceutical or agro-allied industries. In spite of this, Mckinney roundly lost his case against Hacking's experimental realism. To all intents and purposes, Mckinney's case is a case of much ado about nothing! I, therefore, submit that Mckinney's argument is moribund and lacks the motility to override the genuine and valid pragmatic or ontological argument for entity realism presented by Hacking.

However, this is not to say that Hacking's view on experimental realism is completely unassailable. To be sure, it is fool proof only to the extent experimentation has helped scientists to establish their theory with some level of finality.

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