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Ian Hacking's Experimental Autonomy Route to Scientific Realism and David B. Resnik's Objection: a Critical Mediation

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ABSTRACT

Ian Hacking begins his defence of scientific realism with a preliminary attempt to establish the autonomy of scientific experiment. He believes that if an independent life (free from the constraints of scientific theory) is granted to experimentation, then it will ease the way to a robust defence of entity realism. Incidentally, several critics have tried to pin down Hacking's discourse of experimental/entity realism as somewhat defective. In this paper I have chosen to react to one of such critics, namely, David B. Resnik. The basic aim here is to re-examine the core of Resnik's argument against Hacking's strand of scientific Realism. Resnik raises three major issues against Hacking. First, he says that Hacking's experimental realism is a version of "success of science argument". Second, he maintains that belief in unobservable entities is tied to the belief in the truth or approximate truth of the scientific theories explaining or describing the characteristics of some such entities. Then, third, Resnik maintains that, "experimentation is not nearly as theory-free as Hacking maintains". Now, for the purposes of this paper, I took the first two criticisms of Resnik's as less important and have addressed the third issue as most important and worthy of extensive consideration. I argue in this paper that Resnik's third criticism is based on insufficient knowledge of Hacking's two levels of argument in defence of the autonomy of scientific experiment which is ultimately fathered on Resnik's hermeneutical incapacity. I endorse the view that Hacking completely failed to establish an independent life for experimentation by attempting to argue for its primacy at some historic episodes of scientific investigations. But, then, the debate continues with my argument that, Hacking's second-tier argument, which has to do with creation of phenomenon in experimentation, is incontrovertible and provides, in the main, a sufficient basis for his Autonomy Thesis. Therefore, pace Resnik, the presence or non-presence of any definite scientific theory cannot be said to affect Hacking's experimental realism, which ultimately focuses on the manipulation of unobservable entities. Given that this paper is purely qualitative and does not involve any empirical research, I adopted the method of textual analysis.

Keywords:
Experimental Autonomy; Primacy; Phenomenon; experimental Manipulation; Theory-free

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Introduction

Scientific realism discourse has remained an arena of debate ever since Ernst Mach raised the problem of atomism in the late 19th century and the Logical Positivists got embroiled in it – with Moritz Schlick later confessing that the Vienna Circle members have long convinced themselves of the existence of atoms. Looking at Ian Hacking's discussions of experimental realism as a doctrine in its own right, one tends to perceive a virtually unassailable strand of scientific realism – one in need of almost no additional statement. The persuasive simplicity of his argument is appealing, or so it seems to me.

By way of reconstruction, one could rightly say that Hacking began his pursuit with the establishment of the autonomy of scientific experiment at two levels, say, primacy and creation of phenomenon. At the level of primacy, he insists that sometimes experiment precedes theory. At the level of creation of phenomenon, Hacking argues that sometimes certain phenomena/effects are created contrary to some theoretical expectations. Hacking, ultimately, believes that in scientific experiment real entities whose characteristics or causal attributes are already known are manipulated to yield good results about some parts of nature.

But some scholars have subjected Hacking's experimental realism to serious criticism. In this paper, I shall pick one of them and subject his minor and main objections against Hacking's experimental realism to a rigorous interrogation. Despite the number of follies critics seemingly found in Hacking's experimental realism, it is my aim in this present enterprise to make David Resnik take another look at his objections. This is to say that, my article is reducible to a direct textual analysis and reassessment of Resnik's position against Hacking's experimental realism. It does not, in any way, involve empirical verification of results.

In point of fact, whatever it is that has been identified as making Resnik's argument go wrong should be seen as the very harbinger of novelty in this paper. Here, I shovel in a radical charge that Resnik's key rebuttal (i.e., the third criticism) stems essentially from inadequate understanding of the very groundwork done by Hacking in defence of the ontological status of theoretical entities. Hacking fundamentally has a dual-phased argument in his preliminary attempt to defend the autonomy of scientific experiment – which distinction Resnik fails to comprehend or take into any serious account. In my view, Hacking adequately paves the royal route to experimental realism by establishing the autonomy of scientific experiment at the level of creation of phenomenon. To this end, my basic thesis or claim is that, since Hacking was able to establish the autonomy of scientific experiment, despite the meddlesomeness of theory, it is a short to saying that, the actual existence of unobservable entities is perfectly demonstrable within the purview of Hacking's experimental realism discourse.

Granting the foregoing submission, I consider it appropriate, in what follows, to provide a brief highlight on the issue of theory-dominance in scientific realism debate. This will be followed by a presentation of Hacking's two-prong arguments for the autonomy of experiment. More so, I shall look at the roles of experiment and Hacking's central argument of experimental manipulation of entities. Right after that, I shall offer a hardnosed rebuttal against Resnik's objections to Hacking's experimental realism. The paper eventually winds up with a conclusion.

Recounting Some Skirmishes of Theory-Dominance in Scientific Realism Debate

Hacking argues that the defence of scientific realism position could be pursued from two basic fronts, say, theory and experiment. Given the ugly experiences of the sponsors of theory realism, Hacking believes that a more enduring and strategic defence could be mounted from the perspective of experimental realism. He maintains that only the actual existence or ontological status of unobservable entities can

be guaranteed in experimental realism discourse. For Hacking, one can never sustain an exhaustive defence of all the contents of any scientific theory; hence, he veers away from theory realism. This is not to say that he does not anticipate or appreciate the challenges surrounding any worthy defence of scientific realism from the point of view of experimentation.

Hacking had to contend with the radicals, say, R.N. Hanson, T.S. Kuhn, P.K. Feyerabend and Imre Lakatos who generally hold the view that theory is the summit of scientific investigation, so much so that every scientific observation is theory-laden. This implies that experimentation is so strategically tied to theorization to the extent that it cannot be said to have a life of its own. The autonomy of scientific experiment is also interrogated by the social constructivists, namely, Harry Collins, Bruno Latour, Karina Knorr-Cetina, and the rest. They are the off-shoots of the social implications of Anglo-American Kuhnian doctrine, which has its link with the continental tradition that stretches way back to Edmund Husserl, Gaston Bachelard, and Georges Canguilhem, among others (Norris 1-31). For the social constructivists, it is not really the way the world is that matters; rather, it is the case that certain sociological factors do determine scientific knowledge (theory, experiment, and all).

Henceforth, Latour argues that there cannot be any transcendental idea of Nature devoid of any sociological preconception. In his own words: “Nature and society are not two opposite transcendences but one and the same, growing out of the work of mediation”(87-88). Scientists only try to give us the impression that they have access to pure and transparent facts. As it stands, “Scientific facts are indeed constructed”. Some of these facts, as it were, are “too social and too narrated to be truly natural” (Latour 6). Latour, therefore, wonders why accepted and current scientific ideas cannot be subjected to sociological investigations (6). He, then, demands that his *method of anthropology* be applied evenly to study both scientific knowledge and other forms of knowledge.

In any case, most social constructivists tend to hinge their ultimate claim on the famous dispute between Robert Boyle and Thomas Hobbes, wherein the latter argued that the Torricellian Air Pump produced no valid results. It produced *artifacts* and was incapable of grounding scientific knowledge. For Hobbes, the reason is that both the construction and functioning of scientific instruments are governed by a set of theoretical assumptions – i.e., “theory-behind-the-apparatus” (Kitcher 54). Bachelard, the leader of the continental Husserlian tradition of philosophy of science, has re-echoed Hobbes’s idea in such popular quip as, “instruments are reified theories”. This pervading theory-dominance of scientific investigation remains a daunting challenge to Hacking, precisely because if theory is everything, then experiment has nothing to offer.

Bas C. van Fraassen, who is a bona fide constructive empiricist, does not make light the issue when he categorically maintains that *theory* is a major factor in the design of *experiment*. How could one begin to set up experimental instruments without being guided by a theory? And this same theory must direct the experimentalist’s expectations when the results come. Of course, this does not undermine the key position of van Fraassen which espouses that, “For theory construction, experiment has a twofold significance: testing for empirical adequacy of the theory as developed so far, and filling in the blanks, that is, guiding the continuation of the construction, or the completion, of the theory” (74). By maintaining such a position, van Fraassen attempts to nip the idea of autonomy of experiment in the bud. Indeed, for van Fraassen, theories cannot be said to be true of reality, what is required of theories is that they be empirically adequate (by way of saving phenomena, if I am allowed to so interpret). This makes him a direct neighbor of the instrumentalists who teach that theories are mere fictions, tools or instruments that enable us

make predictions about the world we live in. With this mind-set, experiment seems to have totally lost any intrinsic value: theory is everything in experimental design. Hence, it is appropriate to recall the exact words of van Fraassen's:

Scientists aim to discover facts about the world – about the regularities in the observable part of the world. To discover these, one needs experimentation as opposed to reason and reflection. But those regularities are exceedingly subtle and complex, so experimental design is exceedingly difficult. Hence the need for the construction of theories, and for appeal to previously constructed theories to guide the experimental inquiry (73).

The above van Fraassenian passage leaves no one in doubt as to the preference given to theory over against experiment by the dyed-in-the-wool constructive empiricist. Theories that go beyond the observable realm are not to be believed but could be accepted for the purposes of interpreting nature. According van Fraassen (1991), all scientific theories are world pictures showing different interpretations of the phenomenal world. As it stands, van Fraassen maintains that, "…no interpretation ever finishes the task of answering all questions…" regarding reality (481). This antirealist posture does a whole lot of damage to both theory realism and experimental realism, which Hacking particularly tries to defend.

Re-Examining Hacking's Turn to Autonomy Claim

In laboring to identify a favourable ground wherein scientific realism debate could continue unhampered by the menace of implacable critics, Hacking chooses the frontier of experimentation. This so-called favourable ground for scientific realism defence has been dubbed as experimental or entity realism, or merely as causalism, depending on how some of his critics and supporters view the bent of his argument. But that is not our concern in this paper. To be sure, Hacking was never oblivious of what George Agostinho Da Silver said, namely, that "science is the meeting place of two kinds of poetry: the poetry of thought [theory] and the poetry of action [experiment]" (qtd. Goodfield 142). Hacking agrees that these two poetries, namely, theory and experiment interact with one another in the making of scientific knowledge. To my mind, this rapprochement does not show us which of them (theory or experiment) is, heuristically, more important than the other in any scientific investigation.

Be that as it may, Hacking believes that before anything could be done philosophically with experimentation in science, its autonomy must first be firmly established. Now, for Hacking, the uphill task of asserting or establishing the autonomy of scientific experiment could be done at two different levels, even though he does not, strictly speaking, identify them as two levels or phases of argumentation. However, the first level argument is that of primacy, which considers whether theory comes before experiment or the latter comes before the former. Hacking maintains that sometimes experiment comes before theory. He fundamentally uses Humphrey Davy (1772-1829) to put a finger on it. He recognizes this as the thrust of inductivist method of science which was operative at the early stages of development in modern empirical science. This explains why he writes: "We shall find that the relationships between theory and experiment differ at different stages of development…" (154-155). On the side of those who argue that theory must precede experiment Hacking uses Justus von Leibig (1803-73) as one of his favorite models. He argues that von Leibig's model position is amenable to two versions of interpretations, say, the weak and the strong version. The weak version simply claims that "you must have some ideas about nature and your apparatus before you conduct an experiment… Experiments without ideas like these are not experiments at all" (Hacking 153). In the strong version, "your experiment is significant only if you are testing a theory about the phenomena under scrutiny" (Hacking 154). This is a model advanced in the hypothetico-

deductivist or falsificationist approach to scientific investigation.

Beyond the frontiers of induction and deduction (or hypothetico-deductivism), Hacking presents a different case of happy meetings or happy families "in which theory and experiment coming from different directions meet" (159). In addition to this, Hacking notes that we have "a multitude of experimental laws, waiting for a theory" (164). Fortunately, in a different paper, I have tried to cast an extensive glance at Hacking's first level claim of autonomy and pin it down as completely inadequate in the establishment of an independent life for scientific experiment. In the process of unveiling the self-evident weaknesses or loopholes of Hacking's first level argument for autonomy, a historical fact was eventually alluded to, namely that blind inductivist trial and error approach has actually outlived its tolerance in the current state of development in science (Emedolu 8-20).

Now, Hacking's second level of argument rests basically on his conception of scientific experimentation as creation of phenomena. Here, Hacking observes that the prevalent theory-dominated discourses tend to make scholars forget or sidetrack the rudimentary role of experiment which has to do with discovering more facts or secrets about nature. Hacking peeps into the gallery of his master, Francis Bacon, to unveil the very exploratory or heuristic character of experiment, as he writes:

He [Bacon] saw that observation of nature teaches less than experiment. ('The secrets of nature reveal themselves more readily under the vexation of art than when they go their own way'.)

…He told us to experiment in order to 'shake out the folds of nature'. We must 'twist the lion's tail' (246).

Here, Hacking deeply believes that through the turning of the lion's tail some phenomena are created in our contemporary day laboratories. For him, the creation of phenomenon is the fundamental role of experiment. The immediate question then is: What is "phenomenon"? Hacking spends ample time redacting the history of the term "phenomenon" from Greek antiquity to its use in modern empirical science. At any rate, what concerns us is how Hacking particularly defines the term:

A phenomenon is *noteworthy*. A phenomenon is *discernible*. A phenomenon is commonly an event or process of a certain type that occurs regularly under definite circumstances. The word can also denote a unique event that we single out as particularly important. When we know the regularity exhibited in a phenomenon we express it in a law-like generalization. The very *fact* of such a regularity is sometimes called the phenomenon.

…My use of the word 'phenomenon' is like that of the physicists. It must be kept as separate as possible from the philosophers' phenomenalism, phenomenology and private, fleeting sense-data. A phenomenon, for me, is something public, regular, possibly law-like, but perhaps exceptional (221-222).

Allied to this concept of *phenomenon* is the notion of *effect*. Hacking describes an *effect* as a *phenomenon* which physicists consider as *truly instructive*. *Effects* are often named after men or women who discover them in the course of experimental exploration. Hacking, however, offers this subtle variation between "phenomenon" and "effect". He says that though *phenomena* and *effects* may seem to be perfect synonyms, "yet they point in different directions". He espouses that whereas phenomena may encompass the general record of events by gifted observers who do not actually "intervene in the world but watch the stars", *effects* are restricted to regularities discovered by experimental intervention in the world. This is simply to say that effects are those phenomena that appertain specifically to scientific laboratory experimentation (using instruments), not mere observation of facts or events (astronomical or otherwise).

Overall, the importance of *effects* for Hacking is that they are not consciously created. They are

independent occurrences stumbled upon by keen experimental minds. He substantiates his claim with the story of Hall's effect. E. H. Hall was detailed in 1879 by the physicist H. A. Rowland to investigate the theoretical statement made by James Clerk Maxwell in the *Treatise on Electricity and Magnetism,* namely, "that when a conductor carrying a current is under the influence of a magnetic field, the field acts on the conductor but not on the current". Hacking suggests that Hall may have guessed two things from the utterance of Maxwell's, namely, "that the resistance of the conductor might be affected by the field, or that an electric potential might be produced". Perhaps, those were the only thoughts that guided him throughout his experimental investigation. Quite surprisingly, what Hall eventually discovered "was not what Clerk Maxwell thought he might find" (Hacking 225). To be sure, Hall encapsulates his landmark success in these words:

It seemed hardly safe, even then, to believe that a new phenomenon has been discovered, but now after nearly a fortnight has elapsed, and the experiment has been many times and under various circumstances successfully repeated… it is perhaps not too early to declare that the magnet does have an effect on the electric current or at least an effect on the circuit never before expressly observed or proved (qtd. Hacking 225).

According to Hacking, the foregoing instantiation should persuade anyone to accept it as fact that *effects* guarantee a measure of independence to scientific experiment, irrespective of what any scientific theory might have said. Indeed, the emergence of *effect* is an instance where experiment directs theory in order to properly focus it!

A pure historical case of the rise of quantum physics shows clearly that experiment played a pivotal in the overthrow of the classical Newtonian deterministic physics. Heinz R. Pagels packages the failure of deterministic worldview and the transition to quantum indeterminism thus:

It (classical physics) fell not because of some new philosophy or ideology, but by the end of the nineteenth century experimental physicists contacted the atomic structure of matter. What they found was that atomic units of matter behaved in random, uncontrollable ways which deterministic Newtonian physics could not account for. Theoretical physics responded to these new experimental discoveries by inventing a new physical theory, the quantum theory between 1900 and 1926 (5).

To my mind, the above instance constitutes one of the best examples of the operative autonomy of scientific experiment. I submit that Hacking's efforts at this level of creation of phenomena are very robust and yield a huge success in his establishment of the autonomy of scientific experiment. John Ackermann presents a somewhat related picture to the creation of phenomena when he observes that experimental instruments possess the power both to break the circle of influence from theory to observation and to establish *data domains*; thus, allowing a fair dialectics between *theory* and *experimental data*. This becomes a notable, well argued, and mature support for Hacking's campaign for the autonomy of experiment. A tangible lesson to draw from it is that at some point in the *life* or *history* of any theory, experiment is on hand to *direct* and *fine-tune* its rough edges. In fact, this *direction* and *fine-tuning* of a theory stands as the strongest *seal* of autonomy for scientific experiment, if practical demonstration and good logical reasoning is anything to go by. Therefore, regardless of the criticism of David B. Resnik, it is proper to re-examine Hacking's argument on the manipulative use of scientific experiment that further guarantees, to a very degree, the autonomy of experimentation and hit the thrust of Hacking's experimental realism.

1. On the Roles of Experiment and its Manipulative use

There are different roles assigned to scientific experiment by scholars over the years. These identified roles may not be the only ones; there

could be other pivotal roles not yet identified. Here, I will briefly outline some of the identified roles before expounding Hacking's thesis of manipulative use of scientific experiment. Straightforwardly speaking, the *epistemological* role has to do with the part valid experiment plays in theory choice or theory confirmation. This is a very significant role as far as the logical positivists are concerned. Hypotheses and theories must be verified by experiments at every instance of scientific investigation. It is important to at this point to stress that the methods of validation of experiment results is of pivotal importance in the epistemology of experimentation. Hence, Theodore Arabatzis corroborates: "The Analysis and explication of these methods [of validation] is a central task of the epistemology of experimentation" (2014 196). There is also the heuristic role of experiment. This role is played when an experiment enables us to make discoveries or uncover some hidden variables in nature. Carl Hempel captures this heuristic role when he argues that experimentation in science is not only used "as a method of test, but also as a method of discovery" (21). Hacking's discussion of the creation of phenomena of effects in scientific experiment falls under this role. Another special role of scientific experiment is the cognitive role which helps us to understand and think about the world, thereby enabling us interpret how our theory is linked to nature or reality, as it were. In this light, T. S. Kuhn argues that the special telescopes invented "to demonstrate the Copernican prediction of annual parallax; Atwood's machine… to give the first unequivocal demonstration of Newton's second law; Foucault's apparatus to show that the speed of light is greater in air than in water; or the gigantic scintillation counter designed to demonstrate the existence of neutrino…" were all experimental instruments invented to ensure intellectual connectivity between theory and nature (26-27). In fine, we may say that the cognitive role of experiment is "to bring nature and theory into closer and closer agreement" (Kuhn 27). The *illustrative* role celebrates the artifactual ingenuity of model experiments. This particular role is often overemphasized in our time to the detriment of the epistemological, heuristic and cognitive roles. Antirealists always readily point to model experiments (which often play illustrative role) as if they are the only forms of experiment. They deploy model to generalize that experiment, *per se*, has nothing to do with the manipulation of real entities or Nature as such. Fortunately, Mary Hesse is an internationally acclaimed expert in this area. She recognizes the function of metaphors, analogies and models in deductive explanations, and experiments. But this is not to suggest that every metaphor/analogy/model is typical of reality. A model/analogy/metaphor is like a ladder through which we climb the tree of reality; once we get to the treetop it loses its significance. Hence, Hesse would rightly argue that it is not all the time that one should expect perfect conformity between a model and the reality/phenomenon it attempts to represent. Of course, Hesse ultimately asserts:

> Model can be tested, because it is a system of entities and processes whose behaviour is already known apart from the new experimental facts which it is being used to explain (qtd. Shapere 103).

Over the years we have been learning so many things from model experiments through their successes and failures. For example, atomic structure model experiments yielded many cumulative results that led to advancement in nuclear and LASER technology. Historically, scientists transited from J. J. Thomson's free distribution model to Rutherford and Bohr's spherical model. The current vector model is, of course, not the ultimate model. But the one lesson we have learnt from the above revolutions (theory change) is that model experiment gives insight on how to discover and explain certain phenomena which would not have emerged without the postulation of models. Through the models we learn how to reason about and gradually understand the inner constitution of reality. In other words, in the

illustrative/model function we may see a mingling or medley of other functions/roles/uses of experiment (say, *cognitive, heuristic, epistemological, rhetorical* and *aesthetic*). In the book, *The Uses of Experiment: Studies in the Natural Sciences*, edited by David Gooding, Trevor Pinch and Simon Schaffer, one could glean so many other roles experiment performs.

Amid all these roles performed by experiment, one great paradoxical lesson we have learnt, for instance, from the panoply of atomic model experimental experiences is that when experiments do not succeed in confirming the predictions of theories they should not be considered as *failed* experiments. As it were, the so-called *failed* experiments could sometimes be more instructive than *successful* ones. This leads me then to point out the supportive injunction of Francis Bacon's, which runs thus:

No one should be disheartened or confounded if the experiment which he tries do not answer his expectation. For although a successful experiment be more agreeable, yet an unsuccessful one is oftentimes more instructive (qtd. Hacking 247).

To deny that scientific experiment has an independent life of its own is to reject the fact that experiment can open our minds beyond the projections of any standard scientific theory. Without the magisterial presence of experiment there will be nothing like progress in the scientific enterprise: Everything would have been moving around in a whirl pool or vortex of absurdity and ideality, as it is today in the battle field of philosophy. Experiment is not just an otiose artifact; it helps us to discover, understand and adjust better to our world. This is true even in the field of pure theoretical physics; for as Gerald Feinberg and Maurice Goldhaber would say: "…the basic principles of theoretical physics cannot be accepted a priori, no matter how convincing they may seem, but rather must be justified on the basis of relevant experiments" (qtd. Pagels 271).

With the autonomy of experiment well-established by Hacking, he goes further to crystallize it by presenting an elaborate argument with several illustrations as to how unobservable entities are manipulated based on causal principles in the course of experimental investigations. On a deeply personal note he asserts:

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. We understand the effects, we understand the causes, and we use these to find out something else. The same goes for all sorts of other tools of the trade, the devices for getting the circuit on the supercooled niobium ball and other almost endless manipulations of the 'theoretical' (24).

Indeed, it is in scientific experiments that well-known entities are manipulated to yield good results. Hacking insists that, whenever a scientist is experimenting with electrons, for instance, he is actually "creating phenomena in some other domains of nature" (263). This implies, for Hacking, that, "By the time … we can use the electron to manipulate other parts of nature in a systematic way, the electron has ceased to be something hypothetical, something inferred. It has ceased to be theoretical and has become experimental" (262). This somewhat explains why Hacking has strong faith in causalism, believing in the deliverances of scientific instruments, and accepting it as a fact that, in experimentation there is a direct interaction with Reality or Nature, as it were. As Rom Harré explains, our readiness to embrace "…the deliverances of the instrument as a proper record of some natural event depends on our faith in causal relations that obtain between the state of affairs in the world and effect it has on the instrument" (19). Hacking is actually of the view that instrumental noise could be eliminated or complete debugged. On the strength of this, Hacking's strong faith is corroborated by John

Horgan, who clearly declares that, “Scientists do not invent the truth; they discover it” (2).

Ad **David B. Resnik**

Resnik states from the outset that his major task is not to generally criticize Hacking’s doctrine of experimental realism. His aim is to point out three key elements that are found and denied at the same time in Hacking’s experimental brand of realism. Resnik clearly states:

In this paper I argue (1) that Hacking's argument for experimental realism is, despite his strong denials, another version of the 'success of science' argument; (2) that the experimental realist can only have knowledge about theoretical entities if she assumes that the theories which describe those entities are at least approximately true; and (3) that experimentation is not nearly as theory-free as Hacking maintains. The common thread in these three criticisms is that Hacking does not succeed in shifting the defense of realism away from questions about scientific representation. Experimentation is a form of intervention, but it is intervention strongly guided by representation” (395-396).

Before I begin any critical response to Resnik, it is proper to first highlight the fact that Resnik argues that Hacking’s “writing is a bit enigmatic, highly suggestive, and sometimes vague” (400). To my mind, this accusation lacks merit, precisely because Hacking’s text, *Representing and Intervening*, is a masterpiece, wherein he shows his dexterity as a stylist and fine-honed writer. The word “enigma” or “vague” should not in any way be associated with Hacking’s text. To say that it is “highly suggestive” could be tolerated to a marginal extent. A reading of the book itself does not lead anyone to encounter any enigma or experience vagueness or confusion. The text is simple and clear to anyone who has a modicum of understanding of basic arguments in the general philosophy of science.

Now, let’s begin with Resnik’s first claim that, “Hacking’s argument is a ‘success of science argument’ for realism”. He argues that, “While (J. J. C.) Smart and (Richard) Boyd focus on the success of theoretical science, viz., predictive and explanatory success, Hacking focuses on the success of experimental science. Success in experimentation is equated with the ability to reliably manipulate or control our instruments in order to produce desired effects” (Resnik 404). Resnik further stresses that, “Hacking repeatedly asserts that his argument for experimental realism is not just another version of the infamous success of science argument” (405). Resnik cites some passages from some of Hacking’s work, wherein the latter debunks “explanatory success” and rather insist that scientists, especially the experimenters, do not just focus on the deployment of electron to explain phenomena; “They know how to use them (i.e., electrons)” (405).

Here, without much doubts, Resnik is, to a high degree, right in reading “success” into Hacking’s argument. Hacking should not deny that his argument is a strand of success/ultimate argument for realism, even though it has nothing to do with theoretical or explanatory success. It is a fact that explanatory or predictive success cannot save any theory from the imminent danger of being overthrown by a new and more robust theory. Success has never granted any such immunity to theory. But Resnik must be made to understand that in the event of scientific revolutions entities, which Hacking speaks about, most times survive the meta-induction challenge. I am afraid to say they endure, even though they first came as mere imaginary denizens. They gain ontological relevance and some sort of strong immunity against the ever recurrent meta-induction onslaught facing scientific theories, owing specifically to the way we humans structure the material world or reality, so to speak. Now, in spite of the fact that some entities have been superseded, Henri Poincaré attests to the enduring nature of most theoretical entities amid the perennial turbulence of theory change. David Harker loudly harps on what he refers to as ***selective realism*****,** which could also be applied to limiting or narrowing the

success of science to the survival of relevant theoretical or unobservable entities in Hacking's hard-line experimental realism. Hilary Putnam's "No Miracles Argument", which typifies the ultimate or success of science argument, may still be applied in the case of Hacking's entity realism. Harker's *selective realism* runs thus:

The most influential arguments for scientific realism remain centrally concerned with an inference from scientific success to the approximate truth of successful theories. Recently, however, and in response to antirealists' objections from radical discontinuity within the history of science, the arguments have been refined. *Rather than target entire theories, realists narrow their commitments to only certain parts of theories* (79).

In fact, my submission here is that, to retreat to the experimental success of manipulating theoretical entities and using them to study other parts of nature is to retreat to the safest haven one can ever imagine. Success of science and its application to technology remains a fact which both the realist and the antirealist must answer to. If science is a total failure, then there is no need discussing it all. Whether its goal or ultimate aim is prediction, empirical adequacy, truth, application to technology, etc., the baseline is that it is at least approximately succeeding in whatever roles both the realist and the antirealist wishes to assign to it. Therefore, the antirealists have no moral grounds to use the success of science argument in demonizing and threatening the scientific realist of whatever persuasion – they are all in it together.

The second of Resnik's three-prong attack against Hacking's experimental realism reads: "…the experimental realist can only have knowledge about theoretical entities if she assumes that the theories which describe those entities are at least approximately true". Here, the verity of a theory is quite a complex thing: A theory is not just a simple proposition. Resnik cannot dragoon Hacking into believing the complete or approximate truth of any theory. The entity realist is only committed to any hypostatization related to the nature of the entity in contention. In other words, the description of an entity is what captivates the entity realist in a theory, not the entire theory itself.

Following from Hacking's seeming attempt to undermine theorization, Resnik stresses that Hacking's experimental realism lacks rational justification because it fails to provide evident and concrete argument. Thus, he vociferates: "Hacking's claims about using or manipulating physical entities are dogmatic assertions" (405). He argues though that Hacking's entity realism is a "metaphysically consistent position," since someone can comfortably believe in theoretical entities without necessarily accepting the "theories in which they are embedded". To be sure, Resnik insists that, Hacking's position is unreasonable precisely "because it gives the experimenter a belief (and perhaps even a true belief) in theoretical entities without justified belief". According to him, justification remains a necessary condition for authentic knowledge. Hence, "theory-free entity realism cannot yield knowledge about theoretical entities" (Resnik 407). I consider this a misfiring of philosophical reasoning. In matters of existence, practical demonstrations are more powerful justifications that can inspire belief than any a priori logical reasoning. Too much epistemology must have taken over Resnik's judgement. Pretty clearly, I do not really understand Resnik's conception of *justification*; for I still strongly believe that at the ontological level of entity realism whatever Hacking has demonstrated in term of manipulability provides enough empirical evidence, warrant or justification. Beyond mere theorization, experimentation is forever capable of providing a valid justification. To say that "I know John is doing tea inside the house" does not, for instance, require any rigorous theoretical, logical, epistemological or linguistic analysis of either what it means to "do tea" or what it means to "know". The only thing that is required in this particular circumstance is the practical step of walking into the house and seeing John doing the tea, real time. This

provides enough justification for such an empirical claim. If this cannot provide justification for my knowledge that John is doing tea, then nothing else can! In like manner, if Hacking's electrons can be deployed in doing things, then that is enough warrant for their existence claim. If Resnik demands anything beyond this, then he does not understand what *justification* or cognition means in this particular empirical context. Consequently, I maintain that Hacking's argument is reasonable, so long as we are talking in terms of human rationality. I say this because most times scholars bring otherworldly versions of rationality or God's-eye-view of objective knowledge which they cannot even explain or reasonably demonstrate.

The third item Resnik presents is that, "Hacking's view… fails to make a plausible case for theory-free, entity realism. His view is on shaky philosophical ground because it does not allow experimental realists to have knowledge about the entities they investigate" (407). The foregoing statement shows that Resnik read Hacking's text, *Representing and Intervening*, upside down. Fortunately, in the two preceding subsections, I have clearly exposed Hacking's position on the autonomy of scientific experiment (both at the level of primacy and the level of creation of phenomena) and how it stands with experimental manipulation of theoretical entities. Without mincing words, Hacking believes that scientists should have some ideas "about the entities they investigate". The logic is very simple: if one does not have any knowledge (or what Hacking sometimes call "home truth"), how then will one identify anything or attribute any character or behaviour to it? If there is no element of knowledge, then there won't be any basis for laboratory experiments which is fully based on design and expectation, involving material procedure, instrumental model, and phenomenal model. This is the essence of scientific research and investigation. From my readings, Hacking's defence of the autonomy of experiment does not really teach that experiments can go on without certain expectations or even full-blown theory. Experimental scientists do have some knowledge, no matter how crude it may be, "about the entities they investigate". The popular phrase of Hacking's is having "home truth" about electron. In actual fact, this home truth could be gained, not necessarily from the "theoretical mode of knowing" – just to borrow a phrase from Aristotle. As it stands, experimentation, having descended from the craft tradition, could actually enable one gain some knowledge about a given theoretical entity. This sort of knowledge comes through what the ancient Greeks refer to as practical and poetic modes of knowing, and this is essentially part of the cognitive role of experiment. Theory most times directs experiment in an intuitive manner (in most cases), but at some other times experimental encounter with reality tends to bring about some counterintuitive projections. This is precisely the way theory and experiment assist or counterbalance (or compensate) each other in a thoroughgoing scientific investigation of the inner constitution of reality.

Now, Resnik feels he is playing the role of a good critic by advertising that, "… the history of science contains many episodes where theoretical entities have been shown to be mere artifacts" (408). But, then, Resnik's naiveté comes full circle with the following insistence: "for all we know, electrons could be like Mendelian genes: their effects might really be produced by other entities. Or even worse, they might turn out to be like phlogiston and not exist in any way at all" (408). I would rather ask: Is this reasoning not so vaporous? If the effects attributed to genes are produced by other entities, then these entities are genes by other names. In the alternative, one might say there are other forms of genes. This explains why Rod Bertolet presents the following interrogation: "How can all that be reconciled with the claim that 'gene' in Mendelian genetics does not denote, for instance, citrons and recons" (57). Whether the functions of genes have been taken over by citrons, recons, or any other entity, what

Resnik is saying about the non-existence of genes does not hold any water. Genes can only be expunged from biological textbooks when molecular biologists or genetic engineers have discovered other aspects or non-evolutionary ways of looking at character transmission or transfer of hereditary traits. This happens only when they want to quit their job or transmogrify our biological existence into the robotic trans-humanistic stage. In another instance, when scientists identify some malfunctions like Down syndrome as having to do with chromosomal problems, it shows that chromosomes will continue to exist until scientists change course and begin to see some such health challenges as having been brought about by the divine wrath of God, for instance, or some other causes. When I say this, I do not wish to be seen as having doubted the omnipotence of God; I am only trying to be cynical about Resnik's level of reasoning. Of a truth, the wrath of God and chromosomal dysfunction could both in essence be simultaneously validated, since they are not mutually exclusive. Given what I have said so far, to simply argue that, electrons "might turn out to be like phlogiston and not exist in any way at all" is pretty inconsequential, for something must be responsible for whatever role scientists assign to electrons. To say that another entity, namely, oxygen was used as a perfect replacement for some of the roles previously performed by phlogiston, does not remove the fact of the existence of an entity. Some such argument cannot be used to undermine entity realism in a very significant way.

Furthermore, Resnik joins Dudley Shapere in saying that "Hacking's sense of 'use' is ambiguous and vague". Resnik, following Shapere, says that "'use' could be interpreted actively as 'manipulate' or 'control' or more passively as 'employ' or 'exploit'" (402). To my mind, this so-called distinction between *active* and *passive* sense of "use" are equally vague and illusory. There is clearly no significant difference between "manipulation and exploitation", even though they are not perfect synonyms. In the process of manipulation some kind of exploitation is going on. Also one can never exploit without a fervent manipulation. "Control" as well fits into this. The term, "employ", on its own, underpins all the above three terms, namely "manipulate", "control", and "exploit". They are all words sharing the same semantic field, despite some subtle nuances of difference in meaning. So, there is no need raising and wrangling over false problem.

Conclusion

Hacking's experimental realism is almost a self-supportive view of realism. It does not require too much embellishment of words to score its point. What I have done with the latter-day critic, Resnik, is merely to show how not to understand or interpret Hacking. From Hacking's two-pronged argument for autonomy, one deciphers clearly that the presence of a theory in experimentation is not what any one should worry about. Experimentation has a sublime way of distinguishing itself and asserting its independence from any form of theorization. This serves as a lesson to those who presume that Hacking completely discountenances the presence of theory in his experimental realism stance. Theories are the stuffs that forever provide the very ideas that experiments chew upon.

Resnik does a very bad job of interpreting Hacking's text. Textual analysis is not what anyone can rightly do without proper exegetical contextualization of issues involved. I seem to think that Resnik lifts statements from Hacking's text without due consideration to linguistic holism. Though I am not a meaning holist, I have come to understand the fact that decoupling words, phrases, sentences or ideas from their original contexts ("native environments") may lead to serious problems and errors in understanding any given texts (ancient and modern). I presume this is the challenge that Resnik was faced with.

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