PROCEEDINGS OF THE ARISTOTELIAN SOCIETY

CHAIRED BY TIM CRANE
EDITED BY GUY LONGWORTH

SENATE HOUSE
UNIVERSITY OF LONDON

2016-2017
138TH SESSION | VOLUME CXVII

Pragmatist Coherence as the Source of Truth and Reality

HASOK CHANG
UNIVERSITY OF CAMBRIDGE

ARISTOTELIANSOCIETY.ORG.UK

PROCEEDINGS OF THE ARISTOTELIAN SOCIETY
138TH SESSION

ISSUE NO. 2
VOLUME CXVII
2016 - 2017

PRAGMATIST COHERENCE AS THE SOURCE OF TRUTH AND REALITY

HASOK CHANG
UNIVERSITY OF CAMBRIDGE

MONDAY, 9 JANUARY 2017

17.30 - 19.15

THE WOBURN SUITE
SENATE HOUSE
UNIVERSITY OF LONDON
MALET STREET
LONDON WC1E 7HU
UNITED KINGDOM

This event is catered, free of charge & open to the general public

CONTACT
mail@aristoteliansociety.org.uk
www.aristoteliansociety.org.uk

BIOGRAPHY

Hasok Chang is the Hans Rausing Professor of History and Philosophy of Science at the University of Cambridge. Previously he taught for fifteen years at University College London, after receiving his PhD in Philosophy at Stanford University following an undergraduate degree at the California Institute of Technology. He is the author of *Is Water H2O? Evidence, Realism and Pluralism* (Springer, 2012), winner of the 2013 Fernando Gil International Prize, and *Inventing Temperature: Measurement and Scientific Progress* (Oxford University Press, 2004), joint winner of the 2006 Lakatos Award. He is also co-editor (with Catherine Jackson) of *An Element of Controversy: The Life of Chlorine in Science, Medicine, Technology and War* (British Society for the History of Science, 2007), a collection of original work by undergraduate students at University College London. He is a co-founder of the Society for Philosophy of Science in Practice (SPSP), and the Committee for Integrated History and Philosophy of Science. He has recently been the President of the British Society for this History of Science.

EDITORIAL NOTE

PRAGMATIST COHERENCE AS THE SOURCE OF TRUTH AND REALITY

HASOK CHANG, UNIVERSITY OF CAMBRIDGE

In this paper I seek to defend an epistemology that does not confine itself to the knowledge of propositions. In the first section I will try to motivate this move. The second section will discuss further how knowledge may be understood to reside in actions, and advance a notion of pragmatist coherence as the relationship between activities that we should seek. The third and final section will discuss the implications of the notion of coherence, including how it can serve as the core of new notions of truth and reality in the pragmatist tradition.

1. KNOWLEDGE BEYOND PROPOSITIONS

THERE ARE TWO CLASSES OF MOTIVATIONS to go beyond the propositional conception of knowledge. First, it is well known that knowledge has rich non-propositional aspects. Especially to this audience I should not present this as a novel point; after all, it was at here the Aristotelian Society that Gilbert Ryle (1945/46) presented his distinction between "knowing how" and "knowing that", in the Presidential Address seventy years ago now.[1]

It is a very important and meaningful thing to say that "I know how to do X", and I imagine that there are roughly equivalent expressions in most languages. This is a very clear and well-established notion of "knowing", which we should not disregard. It is useful to contrast the conception of knowledge as ability with the conception of knowledge-as-information-storage-and-retrieval ("I know that there are 9 planets in the solar system" – or at least I did, until the recent injustice that was done to Pluto). And "knowing how" and "knowing that" aren't all the only kinds of knowledge, either. To every kind of question "Do you know…" corresponds a different kind of knowledge. So there is not only knowing-how and knowing-that, but also knowing-why (knowledge of causal or intentional explanation), knowing-what/who (recognition of another being), knowing-what-it's-like (empathetic understanding), and perhaps more types besides.

1 A more extended discussion can be found in Ryle (1949), chapter 2.

I would, of course, not say knowing-that is not important (and I will return to this point in Section 3). There are numerous areas of life and science in which knowing-that is crucial (and the same can be said for all other kinds of knowledge, too). But let us start by accepting that knowing-how is perhaps equally important. One reason we should take care to pay attention to knowing-how is that traditional epistemologists have tended to ignore it, despite the urgings from Ryle, Michael Polanyi, and many others. And I would argue that knowing-how is just as important in science as in everyday life.

To get our intuitions going, let's consider briefly some examples of the sort of things that we should want to know in science. Do we know how to analyze a complex organic molecule to ascertain its molecular composition and structure? (And how do we ascertain that we know how to do this? What exactly does it mean for us to *know* such a thing? How do we learn and teach it? How do we learn to do it better?) Do we know, and how do we know, how to compute the trajectory of a planet in the gravitational field of the sun? That may seem like a simple question: we just have to solve the equations of the basic physics involved, whether we take Newtonian mechanics or Einstein's field equation in general relativity, using various techniques for obtaining analytical or numerical solutions. But we also need to ask a host of other questions, starting with: how do we know how to come up with such equations in the first place? Do we know, and how do we know, how to measure inflation, or the level of well-being of a population? Do we know how to test the efficacy of a new pharmaceutical agent? Do we know how to synthesize that molecule? Do we know how to sequence a DNA? Do we know how to run a Monte Carlo simulation of an experiment we can't carry out physically? Do we know how to model a complex situation as a causal graph? Do we know how to make a superconductor that will operate above the temperature of liquid nitrogen? And so on. We should want to have an epistemology that can address these questions of knowledge-as-ability in a direct way, rather than skirting around them in an awkward and round-about way, as the applications of propositions that we believe, or as incidental accompaniments to propositions.

The second type of motivation for moving beyond the propositional conception of knowledge is more negative. There are well-known problems in the philosophy of science that I think stem from the propositional conception. These problems would disappear, or at least changed into a more productive form, if we moved away from the propositional conception. At least since the seismic shock delivered by Thomas Kuhn's *The Structure of Scientific Revolutions* in 1962, philosophy of science has been plagued by doubts about the security of scientific knowledge – not

the global skeptical doubts one may safely set aside, but practical doubts that manifest themselves concerning actual situations of theory-choice. On the one hand we uphold science as the best model of knowledge; on the other hand we are forced to admit, if we pay any attention to the history of science, that scientific change has no clear direction concerning the fundamental ontology of nature, and that our belief in scientific progress is held down by the "pessimistic induction" from the history of nearly all previously trusted scientific theories later being rejected (Laudan 1981). At the heart of this problem is the murkiness of the relation between proposition and reality. If knowledge consists of belief in propositions, then epistemology is a question of the right kind of propositions to believe. The most obvious answer here is that we want to believe true propositions (and for good reasons, to boot). But that answer is inoperable if we do not have a method of determining which propositions are true, which is where we are stuck if we have a correspondence theory of truth and we want to know the truth of statements concerning unobservables.

Kuhn's work also raised a problem about the proper unit of analysis. Philosophers have spoken of "theory-choice" as the task of judgement facing scientists, but Kuhn showed quite convincingly that scientists' choice at the most crucial moments in the history of science was between entire paradigms, rather than merely theories. It is, of course, a matter of debate what exactly was meant by "paradigm", but at least it has to be admitted that a paradigm contains particular methods of work and criteria of judgements, as well as straightforward descriptive statements. So, even if we had a reliable way of judging the truth of the descriptive statements, that is not enough to guide the choice concerning the non-propositional aspects of science. This is at the heart of the Kuhnian incommensurability problem, quite separately from the semantic aspect of that problem concerning the mutual non-translatability of terms occurring in different paradigms. Whether or not one agrees with the details of Kuhn's theory of scientific revolutions, it has to be admitted that our unit of analysis must include something beyond propositions.

2. PRAGMATIST COHERENCE

If we go beyond propositions, what do we say knowledge pertains to? If knowledge is not (only) a matter of possessing true beliefs, then what is it about? The notion of knowledge-as-ability offers some hope here, but how is that notion to be cashed out in more precise terms? This is where pragmatist coherence comes in. Coherence as I intend it is about the fitting-together of actions, not about the logical relationship between propositions; to mark that point clearly, I will use the full phrase "pragmatist

coherence" whenever needed, and just "coherence" when the meaning should be clear enough from context.

2.1. Analysis of science in terms of epistemic activities

In previous publications (Chang 2012; Chang 2014) I have proposed that scientific work (as well as non-scientific but knowledge-related aspects of living) can be analyzed in terms of "epistemic activities" and "systems of practice", which was in conscious contrast to the more customary analysis of scientific knowledge as consisting of propositions. An *epistemic activity* is a coherent set of mental or physical actions (or operations) that are intended to contribute to the production or improvement of knowledge, in a particular way in accordance with some discernible rules (though the rules may be unarticulated). An important part of my proposal is to keep in mind the aims that scientists are trying to achieve in each and every situation. The presence and operation of an identifiable aim is what distinguishes actions and activities from mere physical happenings involving human bodies, and it is also what places knowledge firmly in the realm of actions.

Common types of epistemic activities include measurement, detection, prediction, hypothesis-testing, etc. Some epistemic activities are primarily mental; even Percy Bridgman's operationalism admitted the importance of "paper-and-pencil operations" (1959, p. 3), and Ursula Klein (2003) has stressed the importance of "paper tools" in chemistry. There is such a thing as theoretical practice, consisting in activities including the classification of substances, equation-balancing, the modelling of molecular structures, and the simulation of reactions. In reality, most epistemic activities are both mental and physical at once. Of course propositions are important in science, including observation statements, empirical laws and theoretical principles. However, it is important to understand how they *function* within various epistemic activities.[2]

Epistemic activities normally do not, and should not, occur in isolation. Rather, each one tends to be practiced in relation to others, constituting a whole system. A scientific *system of practice* is formed by a coherent and interacting set of epistemic activities performed with a view to achieve certain aims. It is the overall aims of a system of practice that define what it means for the system to be coherent. Let me illustrate briefly with an example, which I am going to discuss in further detail later on: Antoine Lavoisier created a new system of chemistry whose main activities includ-

2 When we start thinking of scientific work as a collection of activities, an immediately obvious thing is the sheer variety in the types of epistemic activities that scientists engage in.

ed making various chemical reactions involving gases, tracking chemical substances through weight-measurement, classifying compounds according to their compositions, and analyzing organic substances by combustion. The overall aims of this system included determining the composition of various substances, and explaining chemical reactions in terms of the composition of the substances. The coherence of a system goes beyond mere consistency between the propositions involved in its activities; rather, coherence consists in various activities coming together in an effective way toward the achievement of the aims of the system. Coherence comes in degrees and different shapes, and it is necessarily a less precise concept than consistency, which comes well defined through logical axioms.

It may be instructive to draw a comparison-and-contrast between systems of practice and Kuhnian paradigms. Despite some clear similarities, there are also some significant differences, sufficient for me to warrant the articulation of a new concept. As Kuhn freely admitted (1970, pp. 181-190), he used the term "paradigm" in two main senses.[3] The first, of an "exemplar", does not match my sense of "system". The second sense, the "disciplinary matrix", is akin to my concept, but for two main reasons I do not find it helpful. First, I think we need a concept that is more definite and orderly than the Kuhnian paradigm as disciplinary matrix, which can and should incorporate all kinds of elements from fundamental metaphysical principles to institutional structures, with no definite indication of how the whole thing holds together. Kuhn's paradigm concept is also too closely tied to his view of scientific development, which maintained that a paradigm should enjoy a monopoly over an entire scientific discipline in normal phases of science; I have both descriptive and normative objections to that presumption of monopoly.[4]

You may have noticed that the mention of aims and coherence occur in my characterization of both epistemic activities and systems of practice. This may enhance a sense of ambiguity and uncertainty you may feel regarding the levels of description. Isn't each epistemic activity in itself a system of activities? Doesn't combustion-analysis, for example, consist of various simpler activities, such as burning, the absorption of combustion-products using other chemicals, weighing, and percentage-calculations? And isn't it the case that even those simpler activities in themselves consist of yet simpler activities (the act of weight consisting in the placing of samples and weights on balance-pans, reading the number off the scale, etc., etc.)? There is no clear end to this process of activity-analysis, and I do not think one would gain very much by attempting to reach a rock-bottom of atomic operations. The structure of actions and processes are not at-

3 This explication occurs in the 1969 Postscript added in the 2nd edition.

4 See Chang (2012), chapter 5.

omistic in a reductive way, unlike the structure of things and statements.[5] For example, the activity of placing standard weights on a balance-pan inevitably includes activities supporting our assumption that what we are handling are the correct standard weights; this certification-activity may consist in ordering the weights from a reliable supplier, comparing them to a more trusted set of weights, or checking them against certain natural phenomena (e.g., the weight of a certain volume of water at a certain temperature). Whichever option we go with, it is clear that this subordinate activity is not simpler in any clear sense than the main activity of weighing-with-a-balance. The relation between various epistemic activities is ultimately non-reductive and reticular, although in many situations we can gain useful insights from analyzing an activity into its apparent components.

I do not intend to go deeply into the metaphysics of action today.[6] But I should note that when I distinguish higher and lower levels of description, that is only relative and context-dependent; there is no lowest level of description, nor absolutely more or less complex activities. That is the spirit in which I employ the terminology of "epistemic activity" and "system of practice". In each situation in which we study a body of scientific practice, I am proposing to call the overall object a *system*; when it is desired that we should study more closely different aspects of that system, we can analyze the system into different *subordinate activities*, without implying a reductionist metaphysics in which a system is made by a simple addition of various activities which do not really have any connection with each other; even a brick wall is not built like that! What we take as a whole system in a given situation may be seen as a constituent activity of a larger system, and what we see as a constituent activity in a given situation may in a different situation be analyzed as a whole system made up from other activities. This way, my framework is applicable at all levels, and can be zoomed in and out to suit any place that we want to focus on. At each focus-point, we call the overall practice "system" and its constituents "activities", without intending to stick those categorical labels to anything on a permanent basis.

2.2. Pragmatist coherence

I should stress that I mean by pragmatist coherence is not what epistemologists usually mean by "coherence". In the most simple-minded ver-

5 There are, of course, some reasons to be skeptical about the atomistic–reductive structure of things and statements, too, but that is a story for another day.

6 Here I hope to build on Jennifer Hornsby's work, starting with Hornsby (2004). I also want to draw on Marjorie Grene's analysis of the knower as an actor.

sion of the coherence theory of truth, coherence is taken to mean mere logical consistency within a set of statements. This is nothing short of a philosophical disaster, an invitation to vicious circularity and the most problematic kind of relativism; it eliminates any inherent link between knowledge and reality. James O. Young (2015) notes that a more plausible version of the coherence theory "states that the coherence relation is some form of entailment. . . . Another more plausible version . . . is that coherence is mutual explanatory support between propositions." A similar thought to Young's latter formulation is expressed by Richard Foley (1998, p. 157): "Coherentists deny that any beliefs are self-justifying and propose instead that beliefs are justified in so far as they belong to a system of beliefs that are mutually supportive." But the problems of circularity and relativism remain in the idea of propositions rendering one another true by mutual support without anything else to ground any of them.

What I propose instead is a re-vitalized pragmatist notion of "coherence", implicit in John Dewey's theory of knowledge, which is irreducible to logical relations between statements. *I define (pragmatist) coherence as a harmonious fitting-together of actions that leads to the successful achievement of one's aims.* Such coherence may be exhibited in something as simple as the correct coordination of bodily movements needed in riding a bicycle, lighting a match, or walking up the stairs (very difficult to achieve, as we have learned in contemporary robotics), or something as complex as the successful integration of a range of material technologies and various abstract theories in the operation of the global positioning system (GPS). A coherent epistemic activity achieves its aim well, and avoids performative self-contradiction. When we do not heed the sign that warns "watch/mind your step", that rare moment of stumble reminds us how carefully and how well we normally maintain the coherence of our bodily movements in everyday life without even thinking about it.

Pragmatist coherence pertains to an activity, not to a set of propositions. It is defined in relation to the aims of the activity in question. Coherence is the chief characteristic of a successful activity; in fact, coherence and success are pretty much synonymous (though I also want to leave open the possibility of conceiving coherence as the cause of, or the explanation for, success). It should go without saying that pragmatist coherence cannot be achieved by wishful thinking or mere interpersonal agreement. In order to do things successfully in the world, we need to have an understanding or mastery of our surroundings. It is pragmatist coherence, not the mirage of correspondence, that is the vehicle through which the mind-independent world is brought to bear on our knowledge. Pragmatist coherence carries within it the constraint by nature. In fact, having cleared away the ungrammatical illusion of a direct correspondence between proposition

and reality, we can see that pragmatist coherence is the only way in which reality can enter knowledge, the only way in which reality can bear on our practices. (This is also part of the definition of "reality", as we will see.)

To help us think about pragmatist coherence, I propose that we take Neurath's boat, literally: "We are like sailors who have to rebuild their ship on the open sea, without ever being able to dismantle it in dry-dock and reconstruct it from the best components." (Neurath, 1983 [1932/33], p. 92) This is usually taken as a splendid coherentist metaphor for the fitting-together of propositions. But let's try seeing the boat, or rather boat-fixing, as a particular situation illustrating the nature of pragmatist coherence. Is the boat sufficiently water-tight? Can it be made tighter by piecemeal engineering? The "coherence" of what we do with the boat here is not conceived in an absolute way, as logical consistency would be. Rather, it is defined with respect to a very particular purpose, namely keeping the boat afloat.

3. COHERENCE, TRUTH AND REALITY

3.1. A new coherence theory of truth

Having spelled out the notion of pragmatist coherence, I would now like to return to the consideration of propositions and their truth. If coherence is the property of an activity, how does it relate to truth, which is the property of a statement or a proposition? This is a significant and difficult question, but let me at least provide a sketch of an answer. The "pragmatic theory of truth" attributed to William James is widely regarded as absurd, and this has contributed greatly to the unpopularity of pragmatism among tough-minded philosophers. Here is probably the most notorious statement by James (1978 [1907], p. 106): *"The true," to put it very briefly, is only the expedient in the way of our thinking, just as "the right" is only the expedient in the way of our behaving.* Expedient in almost any fashion . . ."

I think James's choice of the word "expedient" here was unfortunate, sounding too much like mere "convenience" or "usefulness". Possibly, the word had quite a different connotation back then; that is for real James scholars to debate. What I want to do is propose a different formulation, in terms of my notion of coherence: *A statement is true in a given circumstance if (belief in) it is (necessarily) involved in a coherent epistemic activity.* What I mean by an "epistemic activity" is a set of mental or physical operations that are intended to contribute to the production or improvement of knowledge in a particular way, in accordance with some

discernible rules.[7]

The epistemic activity involved in the definition of truth does not have to be that of explicit theory-testing. Sometimes a true statement is explicitly verified; other times its truth consists in its involvement in other kinds of successful activities. One thing to note is that if truth is defined in terms of coherence, it has to be a matter of degree, and I think that is right. And the truth of a statement acquired in one epistemic activity may be extended through involvement in other coherent epistemic activities; therefore truth is a matter of scope as well as degree.

When we normally say that mere convenience should not be mistaken for truth, that is because "the truth will out", i.e., not shown to be truth in other situations. The statement quoted above from James actually continues as follows, which tends to confirm my reading of him: ". . . and expedient in the long run and on the whole of course; for what meets expediently all the experience in sight won't necessarily meet all farther experiences equally satisfactorily. Experience, as we know, has ways of *boiling over*, and making us correct our present formulas." The last bit of James's statement actually fits very well with my notion that pragmatist coherence is the only way in which reality gives input into our knowledge. And this gives coherentist truth the mind-independence that realists value most in correspondence truth, while it is an "internal" notion meaningful within a system of practice, not without it. Such a conception of truth easily allows plurality while avoiding arbitrariness.

If a statement is conducive to success in all possible activities for which it is needed, what is the sense of/in claiming that it may not be true but only that things are as if it were true? The latter is a conceptual possibility allowed by the correspondence theory, but not by the pragmatist coherence theory. There should be another word to designate that alleged possibility; this is sometimes done with "Truth with a capital T." If it is spelled/separated out like that, we would have most scientists and ordinary people readily saying "no, we are not talking about Truth here!"[8]

There is one other part of my definition that will definitely raise some worries: belief in a statement may be involved in a coherent activity in a superfluous way (in a way reminiscent of the tacking paradox or the Gettier problem). How do we solve this problem of impostor propositions?

7 For further discussion of epistemic activities (and also what I call *systems of practice*), see Chang (2014). It may not be necessary to specify the activity in question as epistemic, but it would be a reasonable restriction in the philosophy of science.

8 Incidentally: should we write "capital t" or "capital T"? Neither is right. Really, the symbol that occurs in the place of t/T should be what designates that letter without itself assuming either the capital or the lowercase form.

There is no magic solution. As Clarence Irving Lewis (1930, p. 14) put it in his review's of John Dewey's *The Quest for Certainty*: "Salvation is through work; through experimental effort, intelligently directed to an actual human future."

That is to say, in testing the truth of a proposition, we need to check for (pragmatist) necessity: can the coherence of the activity be maintained, can the aims of the activity still be achieved, if we negate the proposition is question? For example, we can work with Maxwell's equations while denying that the ether exists, so we can argue that belief in the existence of the ether was superfluous in relation to the coherence of the activity of solving Maxwell's equations, even though it was not superfluous in Maxwell's original activity of model-building which led him to the equations in the first place. Checking for pragmatic necessity is nothing grander than Mill's method of difference. It may not live up to some overblown image of a philosophical solution, but it is how we get on in science, and in the rest of life, too.

A quick illustration of how this pragmatist coherentist notion of truth works out may be useful. Take the proposition that is perhaps the most important in the history of organic structural chemistry in the 19th century: "Carbon has valency 4," meaning that it was capable of forming 4 bonds with other chemical units (atoms or radicals). This statement was involved in the successful working-out of numerous molecular structures. It was also involved in the understanding and execution of substitution reactions; for example, it was possible to make a body of methane gas (CH_4) absorb a volume of chlorine gas and emit an equal volume of hydrogen gas, turning the methane into chloromethane (CH_3Cl). Such a substitution could be made four times in total, in the end yielding carbon tetrachloride (CCl_4). Such successes, it is fair to say, constitute the truth of "Carbon has valency 4." But this truth was a limited one. We know, for example, that the structure of carbon monoxide remained a mystery for a long time. Even carbon dioxide was not trivial to understand, but it could be accommodated by saying that the carbon atom formed a *double* bond with each of the two oxygen atoms it was combined with (O=C=O), thereby using up all of its 4 bonding-potentials. But it was not clear at all how carbon monoxide (CO) could be understood.

My new coherence theory of truth is ultimately indistinguishable from James's pragmatist theory of truth freed from misunderstandings. According to this conception, if our use of a theory has led to successful outcomes and not as a result of any strange accident or coincidence as far as we can see, then we can and should say, modestly and provisionally, that the relevant statements made in this theory are "true" — in the same sense as

we say that it is true that rabbits have whiskers and live in underground burrows. This "truth" is operational and verifiable. It is the same thing as empirical confirmation, taken in a broad sense. It is achievable, to various degrees, and its pursuit is clearly useful.

3.2. Knowing-that as subordinate to knowing-how

Going one step beyond acknowledging knowing-how as different from, and equally important to, knowing-that, let me propose a philosophical experiment in the spirit of Ryle, who maintained that "knowledge-how is a concept logically prior to the concept of knowledge-that" (1945/46, pp. 4-5, and pp. 15-16). Why don't we try to take knowledge-as-information as *subordinate* to knowledge-as-ability, knowing-that as part of the process of knowing-how, and see how that goes? Will this move generate useful insights? If so, we will have learned some interesting things. If not, we can abandon the experiment. (I have been slowing working out how to do this experiment in the last 25 years, and I think I now know how to do it. It's worked out fairly well so far.)

So, let's start by saying that belief in propositions is only an aspect of knowledge, not its core or essence. In a narrowly pragmatic vein we might ask: what is the use of belief? More generally, we should ask how beliefs fit into our epistemic activities, and into a broader sense of knowledge. It will be easily acknowledged, in the traditional instrumentalist vein, belief can be a tool for action, if it guides us in certain directions. So knowing-that can be a means to knowing-how, as well as the other way around. As a psychological state, belief can be a product, or by-product of action.

But there are also subtler reasons to privilege knowing-how over knowing-that. There is a methodological advantage to following knowing-how, because we can't easily talk about knowing-how while neglecting knowing-that (because the latter is too obviously involved in enabling the former), while it is very easy to focus on knowing-that and lose sight of knowing-how in that process. Now, why should that be the case? I think it is because knowing-how is a higher state of knowledge, which requires a synthesis of various other kinds of knowledge (although perhaps not all types in each case). So, if we try to understand how knowing-how works out, we are likely to run into knowing-that as one of its ingredients. Yet, some knowing-how is also prior to knowing-that, as Ryle points out. Knowing-how precedes knowing-that, at least to the extent knowing-that is expressed verbally, since non-linguistic animals have a great deal of know-how (the spider building its web, the crow using sticks and pebbles as tools). Is that a contradiction or at least a paradox? No, rather, it points to a picture in which knowing-that is merely intermediate stages and as-

pects of a continually evolving system of knowing-how. In such a picture, it is easier to see that scientific knowledge is continuous with everyday knowledge, only more systematic as Paul Hoyningen-Huene has argued.

3.3. A coherence theory of reality

Before closing I must give a more precise pragmatist characterization of that notion of "reality", about which I have been speaking quite loosely so far. In a similar way to how I have defined truth, pragmatist coherence can also ground an operative notion of reality. The easiest way to see this is to start with Ian Hacking's "entity realism": "If you can spray them, then they're real." (Hacking, 1983, p. 23) He adds: "One can believe in some entities without believing in any particular theory in which they are embedded." (*ibid*., p. 29)

Concepts enabling successful investigations deserve our realist confidence. I propose *a coherence theory of reality*: *a putative entity should be considered real if it is employed in a coherent epistemic activity that relies on its existence and its basic properties (by which we identify it)*. This notion of reality (or real-ness) might be written with a lowercase "r" in order to distinguish it from the idea of "Reality" that denotes the whole "world", or some transcendent existence. Like truth in my pragmatist coherentist conception, "small-r" reality comes in different degrees, and is defeasible, as it is based on coherence.[9]

There is an obvious objection to Hacking-type stance, which is actually a blessing in disguise: might we not misunderstand our experiments, presuming that some non-existent entity is involved in it? This seems to have happened with some regularity in the history of science. For example, Joseph Priestley claimed to be able to manipulate *phlogiston*, and one cannot deny that most of his numerous experiments were successful. In the 1770s he made an attempt to "de-phlogisticate" air by reducing a calx (rust) back into metallic form in an enclosed space; the air in that space would give up its phlogiston to the calx, restoring its metallic nature. This seemed to work out, as he obtained a gas that supported combustion exceptionally well; air deprived of its phlogiston would be eager to absorb phlogiston from a combustible substance (which is combustible precisely because it contains plenty of phlogiston that can be removed). This is how Priestley first made the gas that was later dubbed "oxygen" by Antoine Lavoisier. In a less ambiguous experiment, he predicted that a calx could be reduced by heating in inflammable air (later called hydrogen), which he conceived as pure phlogiston. This experiment succeeded brilliantly.

9 C. I. Lewis (1929, chapter 7) employed this device of distinguishing "Reality" and "reality" for similar purposes.

Did Priestley's successes mean that he and his contemporaries should have granted reality to phlogiston? In short, my answer to that question is yes.[10]

William Herschel's discovery of infrared radiation in 1800 supplies a simpler example, though not as satisfyingly outrageous.[11] Having used a prism to make a rainbow-like spectrum from the sunbeam, Herschel found that a thermometer inserted into the dark space beyond the red end of the spectrum detected a good deal of heating effect. According to our modern understanding, Herschel discovered that low-frequency electromagnetic radiation is not detectable by the eye but has a heating effect. That is not how Herschel and many of his contemporaries saw his achievement: they thought that he was using a prism to separate out the rays of caloric (Lavoisier's substance of heat) and the rays of light in the sunbeam. In that interpretation, Herschel successfully directed caloric rays onto the thermometer to raise the temperature. If this doesn't qualify as "spraying," I don't know what does.

I will invoke just one more example, which is quite well known. Not only a great deal of theoretical explanations but numerous experimental interventions in modern chemistry rely on the concept of orbitals and on the detailed knowledge of the number and shapes of various types of atomic and molecular orbitals. But orbitals inhabited by individual electrons have no reality if we take quantum mechanics literally, since all electrons are identical and they cannot be said to occupy different orbitals within a given atom or molecule. Yet, it makes sense to attribute reality to orbitals, on the basis of the successful chemical practices employing them.

Now, don't these cases just amount to a refutation of Hacking's view on realism and my definition of reality, since we know that phlogiston, caloric, and orbitals aren't real? But this response is question-begging: how *do* we know that such entities are not real? On the other hand, why do we think *anything* is real? In this context Hacking (1983, p. 189), with unlikely help from George Berkeley's *A New Theory of Vision*, points out that even our normal 3-D vision concerning "medium-sized dry goods" is only acquired through a conjunction of the senses of vision and muscular tension (involved in moving around and picking things up); Berkeley also reminds us that focusing at various distances involves muscular tension in the eye. What this suggests is that our intuition about reality at the most basic level is based on coherence: in this case, a harmonious convergence of different modalities of sensation in the course of our daily lives.[12]

10 See Chang (2012, chapter 1) for a detailed discussion of the phlogiston case.

11 See Chang and Leonelli (2005) for details on this case.

12 Richard Held (1965) conducted experiments that seemed to show that normal vision failed to develop when kittens were deprived of muscular activity moving themselves

In a similar way, phlogiston within its domain of successful use is as real as tables-and-chairs and cats-and-dogs are in our daily lives. At the basis of this assessment is the notion of pragmatist coherence. Let's consider more carefully what it really means to say "X is real." In a previous publication (Chang, 2012, chapter 4) I saw "Reality" as nature itself, something mind-independent, something that can resist our attempts to deal with it in some particular way that we might prefer. But this sense of "Reality" is like the Kantian thing-in-itself, about which we can and should say nothing. I also advanced a doctrine of "active realism," which is a commitment to learn as much as possible about Reality. But that makes no sense if Reality itself is something one can't say anything about. So I was talking nonsense.

When Hacking says that positrons are real, or when I say phlogiston is real, the sense of it is that a specific *part* or aspect of that unspecified overall Reality is somehow being captured in our conception. And this parsing-out of Reality is crucial in any kind of cognitive activity. If we cannot identify sensible parts (or aspects) of nature, we cannot say anything intelligible, make any kind of analysis, or engage with nature in any specific and directed way. So we have no choice but to worry about whether we are able to do the parsing well.[13] But how can we ever tell whether we have done it correctly? Again, "salvation is through work" — we can never be absolutely sure, but we check, double-check, and try checking in new domains of phenomena.

4. CLOSING REMARKS

I hope I have been able to show that we can retool the notions of truth and reality so that they become operable; thereby we can reclaim these key concepts for the use of people who are actually engaged in the production and improvement of empirical knowledge. We live in the world, and knowledge is only meaningful from that perspective within the world. It is a futile and pernicious philosophical dream to seek the God's-eye view, to hope to find an "external" perspective from which we can tell the "real" shape of the world. Roberto Torretti (2000, p. 114) blasts the "scientific realists" who believe "that reality is well-defined, once and for all, independently of human action and human thought," yet "in a way that can be adequately articulated in human discourse." They hold that science aims to develop "just the sort of discourse which adequately articulates reality — which, as Plato said, 'cuts it at its joints' —, and that modern science is visibly approaching the fulfilment of this aim." He confesses

around.

13 So, in a sense, a kind of entity realism is prior to any truth-realism one might hope for.

that he finds it difficult "to accept any of these statements or even to make sense of them." The notions of truth and reality are perfectly meaningful in the phenomenal realm of representing and intervening, and they should stay in that realm. We need to look away from the correspondence theory of truth, and look instead to J. L. Austin and "how to do things with words" (1962). Then a statement being true will mean that it passes all the tests of correctness that we can apply, as when you say: "Is it true that there is an airport in Cambridge?" (There is.) We know exactly how to answer that question, and how to double-check the answer as needed. As Putnam (1995, p. 10) put it succinctly, paraphrasing James: "Truth . . . must be such that we can say how it is possible for us to grasp what it is."

Department of History and Philosophy of Science
University of Cambridge
Free School Lane
Cambridge CB2 3RH
United Kingdom

REFERENCES

Austin, J. L. (1962). *How to do things with words*. Oxford: Clarendon Press.

Bridgman, P. W. (1959). *The way things are*. Cambridge, Mass.: Harvard University Press.

Chang, H. (2012). *Is water H_2O? Evidence, realism and pluralism*. Dordrecht: Springer.

Chang, H. (2014). Epistemic activities and systems of practice: Units of analysis in philosophy of science after the practice turn. In L. Soler, S. Zwart, M. Lynch, & V. Israel-Jost (Eds.), *Science after the practice turn in the philosophy, history and social studies of science* (pp. 67-79). London and Abingdon: Routledge.

Chang, H., & Leonelli, S. (2005). Infrared metaphysics: The elusive ontology of radiation (part 1). *Studies in History and Philosophy of Science*, *36*, 477-508.

Foley, R. (1998). Justification, epistemic. In E. Craig (Ed.), *Routledge Encyclopedia of Philosophy* (vol. 5, pp. 157-165). London: Routledge.

Grene, M. (1974). *The knower and the known*. Berkeley: University of California Press.

Hacking, I. (1983). *Representing and intervening*. Cambridge: Cambridge University Press.

Held, R. (1965). Plasticity in sensory–motor systems. *Scientific American*, *213 (5)*, 84-94.

Hornsby, J. (2004). Agency and actions. In J. Hyman and H. Steward (Eds.), *Agency and action* (pp. 1-23). Cambridge: Cambridge University Press.

James, W. (1978 [1907]). *Pragmatism* and *The meaning of truth*. Cambridge, MA: Harvard University Press.

Klein, U. (2003). *Experiments, models, paper tools: Cultures of organic chemistry in the nineteenth century*. Stanford: Stanford University Press.

Kuhn, T. S. (1970). *The structure of scientific revolutions*, 2nd ed. Chicago: University of Chicago Press.

Laudan, L. (1981). A Confutation of convergent realism. *Philosophy of*

Science, 48, 19-49.

Lewis, C. I. (1929). *Mind and the world-order: Outline of a theory of knowledge*. New York: Dover.

Lewis, C. I. (1930). [Book review] The quest for certainty: A study of the relation of knowledge and action [by] John Dewey. *The Journal of Philosophy, 27*, 14-25.

Mitchell, S. D. (2003). *Biological complexity and integrative pluralism*. Cambridge: Cambridge University Press.

Neurath, O. (1983 [1932/33]). Protocol statements. In R. S. Cohen, & M. Neurath (Eds.), *Philosophical papers 1913-1946* (pp. 91-99). Dordrecht: Reidel.

Putnam, H. (1987). *The many faces of realism*. Chicago and La Salle: Open Court.

Putnam, H. (1995). *Pragmatism: An open question*. Oxford: Blackwell.

Ryle, G. (1945/46). Knowing how and knowing that: The Presidential Address. *Proceedings of the Aristotelian Society,* New Series, Vol. 46 (1945 - 1946), 1-16.

Ryle, G. (1949) *The concept of mind*. London: Hutchinson.

Torretti, R. (2000). 'Scientific realism' and scientific practice. In E. Agazzi & M. Pauri (Eds.), *The reality of the unobservable* (pp. 113-122). Dordrecht: Kluwer.

Young, J. O. (2015). The coherence theory of truth. In E. N. Zalta (Ed.), *Stanford encyclopedia of philosophy*. http://plato.stanford.edu/entries/truth-coherence/.

THE ARISTOTELIAN SOCIETY