Approaches to Realism

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Scientific realism asserts that the methods of science, combined with the intellectual powers of human beings can give us reliable knowledge of states of the world beyond the limits of perception. Among the varieties of realism, policy realism is based on the principle that taking plausible theories to be putative descriptions of actual states of affairs is the best way to design experiments and to advance our knowledge. We carve out the Umwelt from the welt by the use of our instruments and apparatus. The key procedure in science has been and still is the invention and testing of models—plausibility and empirical adequacy are the marks of a theory based on a model capable of supporting policy realism.

Keywords: policy realism, model, Umwelt

In this paper I propose and discuss the question whether realism is best understood as the name of an epistemological doctrine concerning the limits of empirical knowledge, or whether it should be taken to refer to a practical rule for the enrichment of the scope of experimental projects? In choosing the second line of approach the idea of science as a material and discursive practice becomes the guiding insight. It will also emerge that at the limit of the possibility of developing a research program there is a need to adopt a radically different ontology from that with which scientists have worked until the 20th century. Dispositional concepts must replace occurrent concepts at the "cutting edge".

1. Basic Features of Scientific Realism

1. Human perceptual organs are used to give access to regions of the world that exist independently of the human observers. What people take themselves to see, hear, feel, touch, taste and so on is strongly influenced by conceptual presuppositions.

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2. People have learned to distinguish reliable perceptions from illusions.

3. The methods of science, observation, classification, experimentation and theorising have enabled people to gain reliable knowledge about regions of the world that are not accessible to our unaided perceptual or manipulative powers.

4. Human intellectual powers are capable of developing concepts the meaning of which reaches further than the limits of our perceptual vocabulary with which such knowledge can be expressed.

For example: in the development of fundamental physics of matter in the era of quantum effects the new concept of *affordances* is called for, about which more later. The fact that scientific research reveals a great many aspects of the natural world about which our ancestors and the creators of our languages knew nothing means that to record and reflect upon new phenomena new meanings are required. These are achieved by a variety of semantic processes including analogy, metaphor and the reification of the groundings of dispositions.

1.1 Preliminaries in General Philosophy.

1. Solipsism and Realism are isomorphic—within the solipsist's world the distinctions that are typical of realism can be reproduced. For example, in both one can distinguish between dreaming and waking, between observation and representation, and so on. So a realist need not fear a collapse into radical subjectivism as a threat to a realist interpretation of scientific discourse and practice. (Wittgenstein 1922)

2. What a human being can find by experience is the result of an interaction between conceptual development, sensory capacities, apparatus, and experience. This point of view was worked out early in the 19th century in detail by William Whewell (1984) in his dialectic between theories and observations.

3. This suggests that the nature of instruments and apparatus, in their relationship to the world they are being used to explore, will be an important factor in working out a defensible scientific realism (Bhaskar 2008).

1.2 Varieties of Realism

All attempts to define 'scientific realism' in terms of propositional concepts such as *truth* and/or *verisimilitude* are doomed to failure. In this discussion I will not make yet another futile attempt to find a "theory of truth" that will serve to underpin the claim that the propositional content of some theories expresses facts about a world which cannot be perceived. Scepticism about the possibility of determining the truth of laws of indeterminate scope and about the possibility of determining the truth of laws of indeterminate depth (levels below the reach of perception even enhanced perception) cannot be defeated by philosophical arguments against the idea of truth as a progressive aim. This point was made forcibly by David Hume (1971, IV, 1, 28). Neither *forces* nor *insensible corpuscles* were legitimate empirical concepts.

In this discussion I will defend "policy realism"—the thesis that reading theories and their grounding models as if they represented features of the world beyond our perceptual powers is a defensible interpretation of scientific method (Harré 1986). It will explain how scientific progress, both positive (new things) and negative (disposing of non-existents) is possible. Policy Realism is closely connected to Vihalemm's Practical Realism (Vihalemm 2011).

1.3 Hinges

Among the philosophical tools I will use in this discussion is Wittgenstein's notion of a "hinge" as elaborated and refined in recent years by philosophers who have taken up Wittgenstein's "third period", the writings that include the last section of the *Philosophical Investigations* (1953) and *On Certainty* (1979). According to the authors of these developments, *hinge-practices* are taken for granted unexamined normative procedures, both material and conceptual on which the "door of life" turns as they remain stable ingredients in our form of life (Moyal-Sharrock 2004). For example the practice of consulting old documents to distinguish true or false memory claims, say in a court of law or in writing history is such a hinge-practice. Each hinge-practice is paired with a propositional doppelganger, expressing the empirical content that is presumed to be true in the use of the hinge practice. For example, the practice of history by consulting archeological remains is paired with the doppelganger proposition 'The world was not created 5 minutes ago'. This proposition is empirical and might turn out to be false—though how we would ever know is moot. Hinge propositions are functionally like synthetic a priori positions in the Kantian scheme.

2. Welt and Umwelt

The great Estonian biologist and philosopher, von Uexküll (1926) introduced the concept of *Umwelt* to describe the region of the world (Welt) that is habitable by the members of a certain species. The boundaries of an Umwelt are related to the sensory capacities, food preferences, and means of locomotion and so on of members of the relevant species. The Welt is a totality of unknown extent in content, from which diverse Umwelten are appropriated by various species of animals and plants—and people.

The Umwelt of Homo sapiens extends to the limits of what is perceivable coupled with what is manipulable. Much of what we perceive we can manipulate (Hacking 1983). We can see and feel and taste the sea and we can extract salt from it. We can perceive features of the world that we cannot manipulate, such as the planets. We can manipulate features of the world that we cannot perceive, such as electric fields. In general these domains of the human Umwelt intersect but do not exhaust one another. Much but not all that is perceivable is manipulable, such as the sand on the shore and much but not all that is manipulable is perceivable such as feeding of a camp fire with dry wood. However, galaxies or planets can be perceived but they cannot be manipulated and magnetic fields can be manipulated but they cannot be perceived.

We are ready to believe in the existence of the beings presumed to inhabit both realms of the human Umwelt—the perceivable and the manipulable, beyond the central region where they overlap.

The possibility of various kinds of disparities between the Umwelten of human individuals, small groups and the human species as a whole, must be taken into account later in this paper when we consider the way that the human Umwelt can grow or shrink over time. The common region I will call the Macro-Umwelt and the various limited regions the Micro-Umwelten.

2.1 Human Umwelten

There are two worlds inhabited by human beings with two species of Umwelten.

a. The physical universe: the material Umwelt comprises those regions of the Welt that are available to human perception and manipulation, enhanced by "engineering" advances.

b. The socio-cultural universe: the socio-cultural Umwelt comprises those regions of the socio-cultural Welt that are available to human beings through their skill in symbolic interactions, enhanced by the possibility of learning the customs of exotic cultures and the languages of foreigners. Each cultural-linguistic system makes available a different Micro-Umwelt that may or may not intersect with other Micro-Umwelten.[1]

2.2 Boundaries

The boundaries between the Welt and various Umwelten are in constant change, though at different rates at different times and places. The rates of change, be it in the enlargement or the diminution of the area of an Umwelt, at any given moment are determined by available technical resources and conceptual capacities of the inhabitants, as well as macro environmental changes. Explorations of the surface of the earth required technical innovations in ships and navigation as well as geographical intuitions and insights. Microscopes and telescopes enlarged the human Umwelt, and so do chemical manipulations—changing the boundaries of the available compounds and elements.

The boundaries between socio-cultural Umwelten are similarly unstable. The program of the human sciences could be thought of as a cluster of projects that reveal features of the socio-cultural Welt—the totality of human social formations and interactions, which are not fully included in any mutually available Umwelten. This is complicated by the fact that much of both the Welt and the Umwelten in the cultural domain is partially constructed and so not wholly there to be found. Not only that but we give meanings to features of the material world such as eclipses of the Sun, droughts, epidemics, and so on that are drawn from cultural sources. The social Umwelten include fragments of material Umwelten.

The discussion in this paper is directed to the uses of the concepts of Welt and Umwelt in making sense of realist readings of the physical sciences.

What combination of theoretical and empirical research methods would make a shift in the boundary between Umwelt and Welt possible or perhaps mandatory?

In the natural sciences explanatory iconic models, about which more below, present images of aspects of the Welt beyond the current concepts of the human Umwelt. By taking at least some of these models seriously as possible representations of hitherto unknown regions of the Welt and so as guides to further research projects and as inspirations for the creation of new apparatus and instruments scientific practices can expand the boundaries of the Umwelt and at the same time remove imaginary beings, states and processes from it. With a bolometer we can measure the heat of the stars, and with the understanding that mutation and selection in the world of animals

[1] The socio-cultural Umwelt includes not only social practices, but the bodies of knowledge that social actors draw upon in creating their daily lives. Bodies of knowledge are the targets of research in the newly developing field of Discursive Psychology.

and plants are independent we delete the concept of *inheritance of acquired characteristics* from the list of processes that we believe have occurred in the past.

3. The Step to Policy Realism

Umwelt expands and contracts by the testing models as images of regions of the Welt previously inaccessible either to perception or manipulation, for verisimilitude.

This is the key to the defence of policy realism—it is reasonable to interpret explanatory models as *representations* of possible features of the world.

What makes a model worth testing for verisimilitude, likeness to some feature of the world that it claims to represent? The criteria can be set out in two principles.

1. Empirical adequacy: successful prediction using the model as the basis for a logical move is not to be understood as inductive support for a hypothetical generalisation. Instead we should see it as providing support for the choice of a certain "law" as a prescription for a model that when run reproduces analogues of the phenomena of interest. For example, Dalton's Law of Partial Pressures prescribes a model which when run reproduces the observable behaviour of mixtures of gases.

2. Ontological plausibility: the source of the model that is the core of the theory being tested in phase 1 of the test is coherent with the rest of scientific knowledge at that historical point, particularly with the implicit ontology in play at the time.

If a model is the core of an empirically adequate theory and is coherent with the rest of the science of the era then it is worth trying to create conditions and equipment that will enable us to display the states of affairs, processes, mechanisms etc. represented by the model in perceptual form, or if not then in manipulable form (Aronson et al. 1998).

To elaborate and justify this line of argument we must turn to the uses of models in science.

4. The Methodology of Model Construction

In this paper I am concerned only with iconic models, that is models as representations of something in the natural world by means of a picturing relation—not by the creation of a model as a symbolic formal description, say as an algebraic formula, by means of arbitrary symbols related by semantic conventions only to their subject.[2] Random moving molecules is an iconic model of a gas, and the formula '$p(v - b) + a/v^2 = Rt$' is a formal model of the same gas. By itself the formal model means nothing until it is interpreted in terms of the iconic model (Harré 2004).

4.1 Models as Analogues

As analogues models have positive, (similarities), negative (dissimilarities) and neutral analogies with their targets or subjects.

There must be negative and neutral analogies for the model to be a representation and knowledge enriching device and not an empty clone. The neutral analogy allows for a model to grow by discovery of further similarities and dissimilarities between model and target by drawing on the relation of the model to its source. The above formula (van der Waal's equation) was reached from the original general gas law ($PV = RT$) by drawing on more and more features of the iconic model of molecules as material objects.

The Bohr model of the structure of a hydrogen atom was meant to be like such an atom (if there are any such) in having a central positively charged nucleus and a peripheral electron that is electrically negative. As subatomic physics developed more elaborate atoms were imagined and more features of the planetary basis of the model were included such as the spin of the orbiting electrons.

The model is like its source, the planetary system, in that it consists of a heavy core around which lighter objects orbit.

The model is unlike its source, the planetary system, in that its components are electrically charged.

The model is indeterminate in that discrete electron orbits are neither like nor unlike what electrons "do", and they are unlike anything planets do.

4.2 The Source -Subject Distinction

A model is modelled on a source.

A model is a model of a subject.

a. Type 1 models: source and subject are the same—for example a model of an architectural project.

[2] A reviewer has drawn my attention to way that Charles Sanders Peirce treated all kinds of models as iconic, including algebraic equations. This seems to me to be a mistaken interpretation by Peirce, since an algebraic equation has no empirical content other than the data from which it was originally derived. An additional act of interpretation is required to turn '$E = mc^2$' into the relation between mass and energy from its from its formal derivation from the Lorentz transformation.

b. Type 2 models: source and subject are different—for example a solar system and the Bohr atom as model of atomic substructure.

4.3 Uses of Models

Type 1 models are used to control the analysis of complex phenomena to abstract salient features and to clarify understandings. There may be more than one Type 1 model relevant as an analytical tool for some complex natural system. For example, a geophysical map can be based on geological strata determined by chemical analysis or on layers determined by the fossils they contain, or both.

Type 2 models are used to represent hitherto unobserved and so hypothetical mechanisms, structures, states and process that are suggested as generators of observable phenomena. For example, type theory in chemistry evolved into structural pictures that X ray spectroscopy enables us to take literally as picture of hitherto unobserved features of the material world.

As a general rule Type 2 models represent structures and processes that are not yet within the human Umwelt, though there may be many such items in the Umwelt of a certain human group at a certain time that are similar, and provide the source for the novelties invented by theoreticians. It is this feature that makes iconic models indispensable in the development of the scope and depth of science. However, you might say, does not this happen with formal, mathematical models as theories? A formal, mathematical model does not affect the boundaries of the human Umwelt unless it can be interpreted in such a way that it can be understood to describe some feature of the natural world, hitherto unknown. In order for such a formal model to advance the sciences it must be interpreted by the use of an iconic model. A mathematical model can have empirical adequacy but lacks ontological plausibility until it is interpreted as a description of a plausible iconic model.

The Source-Model relation works well as the basis of ontological plausibility in the case of the electromagnetic model of atomic structure, even when the nature of electrons is hard to grasp in that their motion is modelled mathematically and formally by the Schrödinger equation, or in the context of molecular structure as linear functions of several such equations. Our initial grasp of the Bohr model makes use of well established classical physical principles, laws of electromagnetism and laws of mechanics. In chemistry we create the quantum numbers by quantizing classical structures, e.g. spin up and spin down. But not always—just for the most part. Sometimes in the sciences we find that there is nothing in our everyday world, or even in prior scientific developments that can provide a convincing source for an interpretative model. Models are images of possible worlds constrained by the principle of verisimilitude we have described above.

In short, iconic model making and testing is the only coherent method for realising the program of realism—that is revealing and exploring aspects of the world beyond the range of human abilities of perception and manipulation. In an important insight we have come to realise that pieces of apparatus are also to be treated as models of aspects of reality when we come interpret the results of experimenting with them.

5. Policy Realism

It is rational to adopt the policy of creating iconic models and testing them for the degree to which they represent hitherto unrevealed features of the natural world. The fact that some iconic models fail the "verisimilitude test" is an argument in favour of policy realism. It made sense to test them for verisimilitude. The oft-cited example of 'phlogiston' as a core model in chemistry shows the importance of the verisimilitude test. Of course when a test succeeds the iconic model is very quickly absorbed into the ontology of science as a proper part of the Umwelt. Tectonic plates and genes have joined galaxies and capillaries in almost everyone's world—while the disease causing "mal arias" and the canals on Mars have vanished.

Policy realism is a very simple claim: the history of science displays the efficacy of the adoption of policy realism by the scientific community. It was not always without resistance—whenever the progress of science in revealing hitherto unobserved phenomena has stalled positivism reappears. That philosophical position bids us retreat to the realm of observable phenomena as the only sure ground for scientific truth (Harré 1986).

6. Elaborations

Can we extend the Policy Realism argument to cases in which the subject of the explanatory iconic model cannot be revealed to human perceivers? Robert Boyle's argument for the reality of the corpuscularian ontology that he proposed for the foundations of his chemical work suggests a possible extension of Policy Realism (Boyle 1666).

To show that a certain kind of imperceptible entity exists, Boyle proposed that we demonstrate that a certain kind of manipulation of an entity of that kind has an observable outcome that is not of the same category as the entities that the manipulation affects. He carried out a number of experiments in which he tried to limit the manipulations to which he subjected his experimental material to mechanical actions only, such as dividing and compounding. For example, by crushing a green emerald he produced a white powder. The "stuff" changed its visible appearance as the result of a manipulation that affected only the "bulk, figure texture and motion of the insensible parts", none of which are colours—in short a mechanical action resulted in a change in a non-mechanical property.

If we want to change the properties of a material stuff, then adopting the policy that we presume that it is actually characterised only by its "mechanical" properties, and the rest are secondary, requires us to perform only mechanical actions on it.

In recent times the same principle has been put to work in a great many experimental programs. The Stern-Gerlach experiment involves a change of orientation of an image by means of a magnetic manipulation that could affect only the orientations of the spin axes of the silver ions passing through a magnetic field. A non-magnetic phenomenon is brought about by a magnetic manipulation which could affect only the magnetic attributes of the imperceptible substrate. The change of orientation of the image was not an effect of the magnetic manipulation of it but of the imperceptible magnetic features of silver ions.

7. Affordances

Inevitably the methods of iconic modelling and testing run out. Physics and chemistry have reached depths of fine-grained analysis of substances and their reactions that resist representations by iconic models. Indeed, this should be no surprise, because it is not only likely but probable that the fine structure of the universe as well as its macrostructure will not be similar to the world that our senses and manipulative powers reveal to us (Cartwright 1986).

While still within the realm of a possible extension of the human Umwelt, a fruitful way of expanding the reach of dispositional concepts developed in the seventeenth century. Some attributes of material things are displayed in all circumstances and to all the senses. Locke (1972) called these the "primary qualities". They were picked out by Galileo (1957) as attributes that could be studied in his new science of mechanics. Typically, at that time, shape, size, number, motion, and solidity featured among the primary qualities. Galileo, Locke and others realised that colours and tastes were not displayed by a material thing at all times and places, but only when a human being interacted with a coloured thing and only in certain circumstances. This something is orange if a human being has an orange visual experience when looking at a certain fruit in a good light. Thus what colours we see is conditional on certain contingencies being realised. These are secondary or dispositional attributes (Mumford 1998).

An entity has a disposition even when not displaying it. What is the permanent grounding of that disposition? We surely have no trouble with the idea that there are features of the surface of a solid that differentially reflect light so that the surface looks red to a human being. These features are well within the range of the scientific Umwelt. What is more the display of this disposition is a stable feature of the surface and is displayed to a variety of interaction processes, all of which involve light of certain wavelength. By developing models of the relevant surface features a simple Policy Realism argument supports the idea that these features should be taken to be real to shape further researches.

But what if we were to interact with the surface in one way to yield say a blue appearance, and in another way to yield a red appearance? Would we have to violate the principle of non-contradiction and assert that the same surface was red and blue all over? Surely we would put the difference in the appearance of the surface down a difference in the way we interacted with it. It affords a blue appearance to this manipulation and a red appearance to that manipulation and it is a mistake to try to unify these affordances beyond this apparently preliminary step. Most people, I suppose, would say that we should undertake research to try to find out what it is about the surface that it reacts in this seemingly contradictory way. There *must* be a common feature behind the seeming diversity. Of course there is no necessity about this "must".

When we turn to the comparable situation in subatomic physics we reach an impasse. We can go no further than affordances, dispositions of apparatus/observer-Welt complexes, from which neither component can be detached. "Electrons" appear as particulate phenomena under one kind of manipulation and as wave-like phenomena under another type of manipulation. There is nothing that electrons are in addition to these displays.

7.1 Realism in reality

To complement the Policy Realism conception of scientific method, we must pass on to a Metaphysical Realism of affordances (Gibson 1967). These are potentialities that are permanent but conditional attributes of apparatus-Welt complexes, not of the Welt alone. Only if the apparatus/observe could be detached from the Welt could we restore the old conception of scientific realism defined in terms of the empirical factuality of the propositions of at least some theories.

The link between the two faces of scientific realism is via the principle that dispositions are grounded in occurrent properties of the subject of our researches. Perhaps some day an iconic model that is empirically adequate and ontologically plausible will be invented to represent those occurrent properties of the Welt that ground what we know only as affordances.

But as far as we are concerned, in the last analysis dispositions are grounded in permanent potentialities. The deep ontological project for philosophy of science is to define and defend an ontology of potentialities and powers for which we cannot imagine a stable and persisting grounding, that is the technique of creating iconic models of the unobservable foundations of dispositions must come to an end.

8. Conclusion

There have been many interpretations of realism. I believe that by attending to scientific practice and the ways that scientific representation of the world has ebbed and flowed, we can see that there is one form of realism that both makes sense conceptually and is defensible as a foundation for scientific practice. The realism I hope I have made tenable is not a doctrine concerned with the truth of hypotheses, but with the plausibility of models and rationale of experimental manipulations.

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