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Scientific Objectivity and Framework Transpositions

Patrick A. Heelan
Georgetown University, heelanp@georgetown.edu

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SCIENTIFIC OBJECTIVITY AND FRAMEWORK TRANSPOSITIONS

PATRICK A HEELAN

I. *The classical notion of scientific objectivity*

The classical notion of scientific objectivity is a property of oppositional truth. It is the property of being open to testing by inspection, in principle, by all men, although in practice perhaps, the testing of a scientific claim is restricted to the members of a community of professional experts. It is, moreover, the property of being stable in time, true eternally as it were; for objective truth is thought to express what is so independently of human interests, initiatives, bias, social circumstances and historical environment. Often there is the added connotation that what is is pictured not in its relationship to man, but absolutely, as it re, in itself, or in its relations to the rest of nature, where nature taken to have an essence independently of the meaning conferred on nature by *Dasein.* All this is expressed as truth-invariance relative to synchronous communities of knowers (living at one time epoch) whether sympatric or allopatric (whether living in one country or in different countries): truth-invariance relative to allochronous communities of knowers (living at different time epochs), and truth-invariance relative to the physical transformations and substitutions which define the objective content of a scientific law or theory.

II. *The crisis of scientific objectivity*

Truth-invariance relative to synchronous communities of knowers in all countries of the world seems to be one of the striking facts about science that distinguishes it from common sense or even from philosophy. Science is international, cosmopolitan and has, it is claimed, but one language. So pervasive is this belief about the one language of science that it might seem to be almost part of what we mean by the scientific enterprise, and it was indeed a part of the classical philosophy of Newton, Descartes and Kant which supported the scientific enterprise in the first three hundred years of its existence. We raise the question then: is the truth-invariance of science relative to contemporary living communities of knowers, merely a synthetic empirical claim, or do we in fact, for whatever reason, dignify with the name of science only those claims

which are truth-invariant in this way?

One answer to this question emerges from the consideration of the scientific enterprise as an ongoing historical enterprise. The objective content of scientific theories has changed in the course of time: one theory has replaced another. The new theory, as Butterfield, Conant, Kuhn, Agassi, Feyerabend and others have pointed out, is often inconsistent with the old : Newton's laws of motion with Kepler's or Galileo's, statistical thermodynamics with classical thermodynamics, relativity mechanics with Newtonian mechanics etc. Scientific theories then are not truth-invariant relative to allochronous human communities. There must then be times of crisis in science when two rival theories are in competition, and when truth-invariance relative to synchronous human communities is abrogated, at least for a while. Let us imagine the pace of scientific investigation accelerated so that a scientific theory would be no sooner accepted than it is challenged by a rival. Under these circumstances towards which we are rapidly moving, even truth-invariance relative to synchronous human communities would disappear. Whatever science is, then, if its future is like its past, the fact that it claims the universal allegiance of the human community and seems for the most part at this moment to vindicate its claim, cannot be attributed to the structure of the scientific enterprise, but constitutes a synthetic empirical fact which may well be destined to disappear. To a Popperian, so much the better: every theory must continually be challenged, for without this challenge a scientific theory would become a dogmatic metaphysics lacking an adequate empirical warrant for its continued truth-acceptance.

III. *Meeting the crisis of scientific objectivity*

This challenge to the objectivity of the scientific enterprise can be met in a variety of ways: (1) By the claim that there is a basic set of scientific facts (usually called *observational facts)* which remain invariant under changing theoretical interpretation. This often goes with (2) the claim that scientific theories have merely an instrumentalistic value; they do not picture the world as it is, their role being purely formal, or cybernetic, or calculational, or the source of rules for processing scientific and irreformable data. (3) Another more serious claim, that for example of W Sellars', looks on the scientific enterprise as at any moment of time tentative and pro-visional but *en route* towards the goal of the perfect objective scientific description of the world, the Peircean scientific framework, which alone is or will be definitive science. In this view, the direction the scientific enterprise takes is that of replacing the manifest framework of common sense treated as phenomenal by a more and more adequate scientific framework in which alone ultimately will be expressed the only true description of the world.

I propose to take up and consider in turn all of these strategies, some briefly, others at more length.

IV. *The Myth of the Given*

That there is a basic set of observational scientific facts invariant under changing theoretical interpretation has been challenged by many writers, among them Butterfield, Conant, Kuhn, Agassi, Feyerabend, Sellars and Nartofsky.[2] The argument is that meanings are the product of human conventions. They are not imprinted by events or produced by habits of behavior whether instinctual or acquired by conditioning. Meanings, of course, arise within a human pattern of life and they are in turn verified in events belonging to a human pattern of life. But to claim that the word ` cat ' has a certain meaning, is to claim that people agree to consider cats as unities of a particular kind entering into experience and that the word ` cat ' has been chosen to designate this kind of unity in human experience. Even observational language then is theory-laden. This implies the negative claim that there is no given primordial core to human experience the description of which provides the basic conceptual framework to which all other conceptual frame-works are reduced logically or epistemologically.

The reason for this rejection of any primordial given is that there is no experience which is not an experience *of a certain kind* and that, consequently, the descriptive framework antecedes the possession of the experience. There is, of course, a pre-experience, whether playing the role of myth or that of an inquisitive but not yet structured awareness. A variety of terms have been used for this pre-experience: *the tacit dimension underlying a problem, the known unknown, the heuristic anticipation of the conceptual framework to be generated by insight and formulation.* Whatever these are, they do not generate of themselves unique and irreformable sets of concepts. This is not to say that a conceptual framework is arbitrary. It is necessarily conditioned by habits instinctual and acquired and by the structure of the environment. But it is not uniquely specified by these physical circumstances, and in that sense, it is not irreformable. The history of the concept of motion provides a case in point: from the Aristotelian desire for a goal, to the notion of motion as a velocity and a transient indwelling force producing it (the impetus theory) to the motion of Newtonian dynamics and thence to the motion described by relativity and curved space-time. You might say that these are examples of *theories of motion* and not descriptions of what we observe. In reply, it can be said that what we observe depends on what we understand to be the case; and if we understand motion to be the outcome of a desire, or the product of a force or a free movement in curved space-time, then this is what we observe.'

This rejection of a privileged set of basic observational concepts

considered as irreformable because received passively from the object, is not to be taken as a rejection of criteria for testing hypotheses. For the testing of a hypothesis requires only that there be a distinction between basic non-hypothetical (call them `observational ') sentences and the sentence to be tested. However, it is not necessary that the basic non-hypothetical sentences be irreformably given in order that they might function in the testing of an as yet undecided sentence.[4] This problem, the *Basisproblematik,* has a considerable literature and solutions range from the conventionality supported by Poincaré, Carnap and Shefller[5] where the decision of the linguistic community is paramount, to a view like that of Putnam' which claims that there is only one non-arbitrary basic framework. My own view on the question of conventionality, its freedom and its limitations, will be given in section VI.

V. *The replacement of one framework by another in the same tradition*

I wish to consider four different cases of relationships between frameworks.

First, there is the case where different conceptual frameworks, which use nevertheless the same vocabulary or linguistic tokens, range over some common domain of facts where they are found to make different and mutually inconsistent predictions. For example, classical thermodynamics and statistical thermodynamics yield different results with regard to temperature and entropy predictions. If for example in the domain of small temperature fluctuations, those made by statistical thermodynamics are verified, as they seem to be, statistical thermodynamics ought to *replace* classical thermodynamics as the account of what is observed. Both theories cannot be simultaneously held, if in the domain where the difference is significant, they yield inconsistent results. This is a case of a framework being replaced by a more accurate one, but one concerned with the same kinds of problems. The analogue in philosophy would be the replacement of one conceptual frame-work by another *in the same* tradition as its predecessor.

The question arises, can two different frameworks range over a common domain of facts? For common facts imply common meanings, and common meanings imply one common framework.

Two quite different cases might be considered. The first is where the second framework contains a sub-framework which forms part of the original framework. Whether such cases exist, I am not sure. But if such did exist, the sub-framework common to the rival frameworks might provide the common range of facts in question. A surer example than that of thermodynamics is that of whether geodetic measurements with light rays obey a Euclidean or a non-

Euclidean geometry. Here the criteria are angle measurements at the three corners of a large geodetic triangle. Since the notion of the angle subtended by two lines involves theoretically only the immediate neighbourhood of the point *of* intersection where Euclidean and non-Euclidean geometries coincide, both the meaning and the operational criteria for such a concept should be the same in both cases.

The second case supposes that there is no sub-framework in common between the two frameworks. Since there are no meanings in common, there is no description made in the original framework which remains meaning-invariant under the transposition of frame-work. Does this imply that no common set of facts bridges the transposition? Two kinds of facts can be distinguished: *sign facts* and *signified -facts.* The former, while possessing their own descriptive framework, function in a certain context as a signal or communications medium, by means of which we infer the answers to a question formulated in the space of signified-facts. For example, looking at a lightning flash (sign-fact), I infer that the atmosphere has been ionized (signified-fact 1 formulated in conceptual frame-work 1). Had I entertained, however, the alternative hypothesis that Zeus was angry (signified-fact 2 formulated in conceptual framework 2), I might have read the same sign-fact differently. In this case, the common range of facts which remains invariant under the transpositions of (explanatory) framework is a range of facts described (usually) in the common sense framework and playing the role of sign to signified.'

VI. *Incommensurable frameworks and multiple mutually exclusive horizons*

The second case is where different conceptual frameworks, which use nevertheless the same linguistic tokens, have no common domain of facts, because the categorizations are *incommensurable.* The latter is the realm of *conventionality* in theory and observation.

For example, one is presented with the problem of describing the geometry of perceived objects within the context of everyday life. Two, perhaps more, languages are available. One is the ordinary spatial language to which we have become habituated, which is based upon a rule of congruence (a rule for deciding when two lengths are equal) which involves the transportation of rigid rulers. This is the language of carpenters, architects and the man in the street. Its way of geometrizing the world has been handed down to us by our classical past, and its product is the Euclidean space of classical physics and everyday functional living. On the other hand, with the consent of a sufficient public, we could adopt a language meaningful, of course, only to that public, where the rule of length congruence was based upon a binocular visual estimate under standardized conditions. This alternative geometrization yields, as Luneburg has shown,[8]

with some simple assumptions and under certain restrictive conditions, a Riemannian geometry of constant curvature.

The latter case can be illustrated by the space represented in post-impressionist painting, which is, I believe, deeply affected by a new awareness of the anomalous (Riemannian?) structure of visual space. In this connection, a mathematical analysis was made by the author of the visual forms which ordinary rectilinear physical objects, like tables, chairs, floors, walls, ceilings etc. would have in the perception of an observer habituated to constituting his space by binocular visual comparisons.[9] Among the conclusions of this analysis were, for instance, that such an observer would notice the tilting of the floor plane upwards towards the horizon, the bringing forward of distant objects, the protruding of nearby objects which appear in inverse perspective and the bending of lines in certain predictable ways. To people habituated to a Euclidean interpretation of their experience, these anomalies inconsistent with the conventional Euclidean geometrization of space would have but one name: ` perceptual illusions'. Some of these ` illusions ' have been noticed in the course of experiments on human perception, and a fruitful field of experimentation is here open to anyone who cares to undertake the work involved.

More interestingly, however, all the pecularities 1 have mentioned and others predicted by the theory of a Riemannian visual space are found represented in the paintings of Vincent Van Gogh and Paul Cezanne. These painters, although they were not geometers, learnt to speak a new spatial language, different from the conventional language of classical science—the language of binocular visual geometry. This was a new linguistic convention but it was not an arbitrary one, if my interpretation of Van Gogh and Cézanne is correct. It was rooted in a new awareness of visual space resulting in a new geometrization of space and consequently, a new experience of geometrical relationships between objects.

Meaning, language and conceptual frameworks are, then, conventional but not arbitrary, since they must conform to possible human experience. There may be, however, no way of describing the untapped possibilities of human experience, whether with reference to a past epoch or with respect to the present. Actual experience may be our only guide. One is tempted to say that a conceptual framework must conform to the facts. But, then, there are no facts antecedent to human experience. Every conceptual framework makes the facts it conforms to by establishing the relevant categories, even though it cannot legislate which of these categories will be filled. In this sense, it makes facts, but cannot make them by an arbitrary *fiat.* The arbitrariness of Carnap's conventionalism is removed from this account of conventionalism as is the opposite view of Putnam and others that claims

conventionalism plays or should play no part in the formulation of scientific truth.

To summarize: the truth of a conceptual framework is in relation to a pattern of conditioned exploratory behavior, but it is not simply the pattern of conditioned exploratory behavior, nor does this pattern uniquely, without conventions, determine the meanings of the framework concepts. Moreover, whether a community chooses to condition itself to one pattern of human behavior or to another is to some extent a matter of choice: not absolutely, however, since they must at least ensure the survival of the human species, but many patterns of human exploratory behavior are in fact culturally contingent.

The example I have taken is of two incommensurable geometrical conceptual frameworks, Euclidean and Riemannian, each of which being a possible form of the human experience of space. These two frameworks cannot, however, be combined into one description without incoherence. They are two separate incommensurable spatial descriptions, not different aspects of one thing. The root of their incommensurability lies in this that they are embodied in two mutually exclusive sets of human heuristic behavior

I want to introduce the following terminology:[10]

intentionality-structure: the heuristic or meaning-structure of a pattern of human exploratory behavior: when formulated, the meaning is a set of basic framework concepts: I am not supposing that there is a unique formulation for every intentionality-structure.

horizon: the set of possible objective (intersubjective) facts attain-able by and through a functioning intentionality-structure, equipped with a conceptual framework.

language: the set of external tokens into which the facts belonging to the horizon are mapped: the language pictures by being a kind of projection of a horizon of human experience onto a domain of external signs: a language then is the embodiment in external signs of a conceptual framework.

linguistic context: another name for an intentionality-structure in so far as it is the necessary condition for the use of a language.

The two cases we have considered up to this are those of the *replacement* of one horizon by another more adequate than the first but within, as it were, the same tradition: and the synchronous existence of *multiple though*

mutually exclusive horizons standing for a variety of valid projections of human experience. These constitute different and incommensurable traditions.

VII. *Complementary frameworks and complementary horizons*

A third case is that of the complementarity *of horizons.* Here my paradigm is quantum mechanics. The word ' complementarity' is Bohr's, but I want to separate myself from Bohr's philosophy, as for example, this is outlined in Aage Petersen's account.[11] Quantum mechanics with its complementary languages illustrates a peculiarity of a wide class of context-dependent languages—that they are mutually exclusive yet not absolutely so. They resist combination on the one hand, and on the other, they can be combined within a broader more inclusive language, which, how-ever, is not in a Boolean relation to the original languages, but stands to them in the non-Boolean relation of a non-distributive lattice. This will be explained below.

The paradigm case is precise position language L_a and precise momentum language L_b in quantum mechanics. Each corresponds to its own measurement context—precise position language is the linguistic projection of precise position-measurement-contexts, precise momentum language is the linguistic projection of precise momentum-measurement-contexts. Bohr and Heisenberg and most complementarity physicists claim that these languages are subsets of the kinematical language of classical physics. That this is mistaken was pointed out by Feyerabend[12] and the present author. In a paper read at a meeting of the Boston Colloquium for the Philosophy of Science, the author showed that the position and momentum languages are subsets of a broader quantum mechanical kinematical language L_{ab} in which the space-time description of any quantum system can be formulated, whether or not the system is found in a precise position or precise momentum-measurementcontext.[13] The author showed that L_a, L_b, L_{ab} and their complements suitably defined constitute an orthocomplemented non-distributive lattice of languages, L_a and L_b can then be said to be *complementary in* L_{ab}. This is not the same as what Bohr meant, since L_{ab} neither contains nor is contained by the kinematical language of classical physics. It simply replaces it.

The relationships between the three languages L_a, L_b and L_{ab} can be illustrated by means of an analogy taken from biology. Two isolated allopatric stable populations A and B of the same species exist in different environments, say, on either side of a broad impassable river. Each population has its own set and distribution of genotypes, G_a and G_b respectively. A Boolean union of the two populations would be one where the distribution of the genotypes would be just the set theoretic sum of the genotypes of the two populations. A Boolean union

of two such populations if it makes scientific sense at all, makes sense only if the geographical barrier between the two populations remains intact. But if the geographical barrier is removed, say, by building a bridge across the river, each population is able to invade the territory of the other. New selection pressures arise, genes are exchanged, and possibly new hybrids are formed. The exchange of genes, hybridization and natural selection work in the course of time to produce a new steady-state distribution of genotypes G_{ab} in the expanded stabilized population AB, which now occupies the whole territory. G_{ab} will be quite different from a Boolean union of the two original distributions G_a and G_b. The genotypes of populations A and B, even though presumably they all persist among the genotypes of the united stabilized population AB, are in a non-Boolean relation to the latter. The non-Boolean relationships between G_a, G_b and G_{ab} constitute what is called a non-distributive lattice.

Returning to the languages L_a of position and L_b of momentum in quantum mechanics, we can define complements L'_a and L'_b of L_a and L_b respectively in such a way that L_a , L_b , L'_a , L'_b, L_{ab} and L_o (the complement of L_{ab}, constitute an orthocomplemented non-distributive lattice of the kind sketched out in the diagram below:[14]

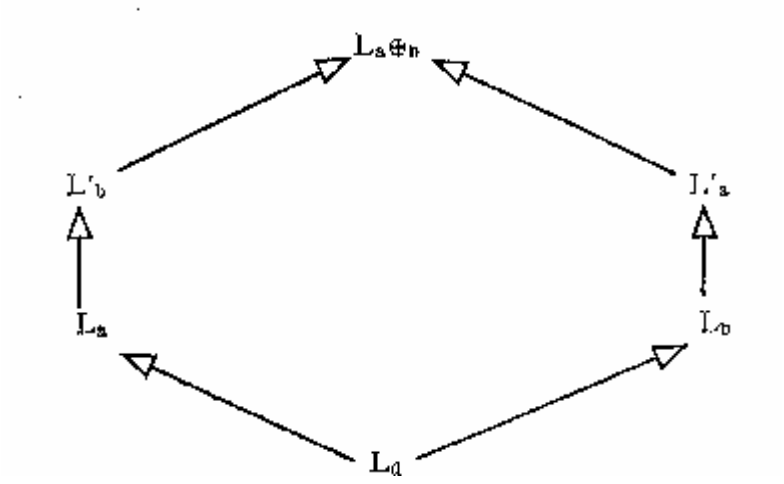

Diagram of the orthocomplemented.non-distributive lattice of (L_o, L_a, L'_b, L'_a, L_b, L_{ab}).

The relationship represented by the arrow is a transitive reflexive relation called `partial ordering'. Whenever any two elements L_x and L_y can be connected by an arrow i.e. whenever $L_x \rightarrow L_y$, then we say that L_x *implies* Ly: the partial ordering is spoken of as *implication.* Moreover, the least upper bound (l.u.b.) and the greatest lower bound (g.l.b.) can be defined in the

following way: L_z is the l.u.b. of L_x. and L_y if and only if both L_x and L_y imply L_z , and L_z is the lowest such element in the diagram with that property. L_w is the g.l.b. of L_x and L_y if and only if L_w implies both L_x and L_y, and L_w is the highest such element in the diagram with such a property. The following notation is used:

for the l.u.b., $L_z = L_x + L_y$; for the g.l.b., $L_w = L_x \times L_y$.

From this it follows that:

$L_x \rightarrow L_{,y}$ if and only if $L_x = L_x + L_y$ and $L_y = L_x + L_y$. Moreover every element of the lattice, L_x, has a unique complement represented by L'_x with the properties that:

$L_x + L'_x = L_{ab}$, $L_x \times L'_x = L_o$, and $L''_x = L_x$

The orthocomplemented lattice in the diagram is non-distributive since,

$L_a \times (L'_b + L_b) = L_a$, while

$(L_a \times L'_b) + (L_a \times L_b) = L'_b$

Where, however, $L_a \neq L'_b$

Consequently, the operation 'x' is not distributive over the operation '+'.

Tlis kind of lattice dif[f]ers from a Boolean lattice where the basic lerations are always distributive.[15]

The elements of the lattice are not descriptive kinematical sentences of quantum mechanics, but a set of six distinct quantum mechanical languages**,** each treated as an indivisible element of the lattice. The partial ordering ` → ' or 'implication' between two languages L_a and L_y is to be given the following interpretation :

$L_x \rightarrow L_y$ if and only if every sentence in L_x is also a sentence of L_y. The l.u.b., then, of two languages L_x and L_y is the smallest language L_z such that $L_x \rightarrow L_z$ and $L_y \rightarrow L_z$. This corresponds to the most restricted situation where either one or other language is appropriate. The g.l.b. of any two languages L_x and L_y is then the largest language L_w such that $L_w \rightarrow L_x$ and $L_w \rightarrow L_y$. T'his corresponds to the most general situation where both languages are simultaneously appropriate.

The lattice of six distinct languages can be re-interpreted as a logic for propositions in a meta-context-language, a language that speaks about events conditioned by, let us say, 'complementary' contexts. In this meta-context-

language, the logical sum (`p or q') of two sentences p and q is mapped on the 1.u.b. of the two sentences (‘p + q'); the logical product ('p and q') is represented by the g.l.b. (`p x q'); negation (`not-p') is *complementation*. The partial ordering of p and q (`p → q') is *implication*. The correct locus for the non-classical logic of quantum mechanics is, I have shown in the papers referred to, this higher meta-linguistic level.[16] The logic of the lower levels, contrary to the received view, is or could be classical throughout.

A similar logical situation arises, for example, in the case of two such dissimilar linguistic contexts as those of the Aristotelian tradition on the one hand and of the Augustinian-Platonic tradition on the other when they met in Aquinas during the Middle Ages. Each linguistic context in conceptual isolation, excludes the other, in the sense that at best confusion and at worst (syntactic) contradictions would arise if statements belonging to the two different traditions were combined in one argument. Let L_a be Aristotelian language and L_b, Augustinian-Platonic language. Aquinas combined both of these traditions, call them A and B into a new linguistic context AB with its own language L_{ab}. The new language L_{ab} contains both Aristotelian and Augustinian subsets L_a and L_b but it transcends both by making a coherent but non-Boolean synthesis of them. The language L_{ab} of Thomas Aquinas contains L_a and L_b in the way that quantum mechanical kinematical language contains the two complementary quantum mechanical languages of position and momentum. In this new precise sense of complementarity, Aristotle and Augustine are complementary to one another in Thomas. L_{ab} is a language in equilibrium, more or less, with the critical philosophical experience of a community of Aristotelians, Augustinians and Thomists.

Other examples of pairs of complementary languages are those of biophysics and biology, of structure and function, of essence and process, of esthetic beauty and functional utility, etc.

What I have described as the synthesis of two complementary languages may be thought of under certain circumstances as the outcome of a Hegelian dialectic in a community polarized by the functioning of two mutually antithetical linguistic contexts or traditions. If $(L_a)^0$ denotes the language of the original thesis, and $(L_b)^0$ denotes the language of the original antithesis, then one would expect that in the course of the dialectic $(L_a)^0$ would be replaced by L_a, a language in the same tradition as the first but more adequate than it, and similarly that $(L_b)^0$ would be replaced by L_b, a language in the same tradition as the first but more adequate than it, and that the final outcome of the dialectic would be the non-Boolean synthesis of L_a and L_b in L_{ab}. It is the non-Boolean character of the eventual synthesis that guarantees that the synthesis is richer than either of the partial

languages L_a and L_b or even both taken in mutual contextual isolation. The possibility of extending the notion of a dialectic between two complementary traditions to one involving three or more complementary or mutually antithetical traditions is suggested by the fact that the relation of forming part of an orthocomplemented non-distributive lattice is not restricted to just a pair of complementary languages, but could involve three or more.[17]

The value of the analysis I have just given over other proposals for the use of a non-classical logic in quantum mechanics and elsewhere is manifold. Firstly, the claim that the context-languages constitute an orthocomplemented non-distributive lattice is a precise, well-defined claim which is subject to falsifying tests. Secondly, it enables classical logic to be retained, if there are good reasons for retaining it, on the level of each of the related object languages, L_a, L_b and the language of the synthetic context L_{ab}. Non-classical logic need enter only when complementary contexts are combined, and in this case, it functions solely on the meta-linguistic level of a meta-context-language which is itself a part of the philosophy of the languages concerned and does not affect the use of the language! themselves. Thirdly, the account I have just roposed can be the starting-point for many investigations in the philosophy and history of science and in the metascience of science d philosophy. One suspects that within the synthesis which is lug foreshadowed between analysis and phenomenology that each of the old traditions will be shown to be complementary to the other in the sense I have stipulated within the future synthesis. Finally there is the possibility of constructing a theory of the development of frameworks on the basis of the relationship between the concepts and usages in the complementary languages and the new developed roles they play in the language of the synthetic context.

VIII. *The Manifest and the Scientific Frameworks*

The fourth case concerns the relationship between two kinds of frameworks, that called ` the manifest framework ' in which we describe objects by means of perceptual predicates referring to the contents of the intuitions of color, continuous extension, solidity, etc. and the scientific frameworks in which postulated and inferred entities play an explanatory role. The question I want to raise is: which of the frameworks describes what the physical world is really like? Which of Eddington's[18] two tables is the *real* table—the solid, continuous, colored table, or the discontinuous swarm of agitated colorless molecules?

I am for the moment concerned with only two points : (i) assuming that the scientific framework describes what is really the case, does this imply that the descriptive predicates of the manifest framework are merely appearances in the sense of *phenomena?* And (ii) is it plausible that the

history of scientific frameworks is the history of a movement towards the unique perfect scientific description of the physical world (towards a Peircean framework)?

(i) I have elsewhere expounded my view that concepts articulate distinctions made by a human subject within a patterned way of life and that consequently every concept relates an object, directly or indirectly, to man who, as *Dasein*, constitutes his World around him by his purposeful, exploratory activity. This purposeful exploratory activity can relate the object to the subject in either of two ways. Firstly, it may reveal an object in its direct relation to man's bodily sensibility, his needs and his purposes. This is the horizon of things-to-subjects-for-subjects and it includes the manifest framework. Secondly, it may reveal the object in its relation to macroscopic instrumental contexts. These serve the dual purpose of being physical relata with respect to the scientific description and of producing signals which serve as a communications channel for the scientist to read. What I have just described are the scientific horizons of things-to-instruments-for-subjects, where public sign-facts describable in the manifest image become the media through which cognitive entry is made into the new horizon of signified scientific facts.

On this account both the manifest and the scientific frameworks yield true descriptions of what is the case, but in relation to different patterns of heuristic behavior. Relative to the scientific horizon, the sign-fact which is located in the manifest framework is one of the characteristic modes under which the scientific-fact appears: in that sense, a sign-fact in the manifest framework is not one of the realities of the scientific horizon, but the appearance of a reality (in that horizon). It is not a mere appearance, however, since within the horizon of the manifest framework, a horizon of things-to-subjects-for-subjects, the sign-fact has its own reality.

But it might be argued that one and the same object (e.g. a table) cannot have at one and the same time the opposing characteristics of continuity and discontinuity, solidity and relative emptiness, color and absence of color, if one (the scientific) set is noumenal, the other (the manifest) set must be phenomenal. We should have to agree with the objection if each of the opposing predicates referred to an absolute character of the object, i.e. to the object not as related through a pattern of interactivity with its environment. But since these predicates arise only within and in relation to such a pattern of interactivity, they are not absolute characteristics of the object but characteristics of the object-as-constituted by the subject within a certain pattern of human heuristic behavior. To the extent that the behavior pattern of a scientific investigation is different from the behavior pattern which reveals the horizon of the manifest framework, we have no way of

comparing the predicates of one frame with those of another.

(ii) Finally, is it plausible that scientific description is moving towards the ideal of a unique, perfect and definitive description of the physical world?

On the one hand, the doctrine of complementary frameworks expounded in section VII shows how it is possible for rival frame-works to come together in a synthesis which contains each and is larger than both. This renders plausible the view that the outcome of a historical dialectic between complementary scientific theories might well be cumulative, leading to successive syntheses in the sense proposed in section VII, rather than to a discontinuous non-cumulative sequence of historical `paradigms' or frameworks which seems to be Kuhn's reading of the history of science."

On the other hand, the discussions of sections IV and VI strongly suggest two things: (a) the contingency of human patterns of life, and (b) the conventional character of the conceptual framework we use to give meaning to a pattern of life considered as a means of exploring and so constituting a World. These considerations render implausible the claim that science, cumulative and progressive as it may be in the sense of the preceding paragraph, is moving towards a unique and definitive goal independently of the path the h'story of science takes to reach it. It would be difficult indeed to know how to go about justifying this Spinozistic claim. Sellars who makes this claim scarcely attempts to justify it: it is in the last analysis one of the basic options which define for a man the meaning for him of a philosophical enterprise.

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