PHILOSOPHY

AND

SCIENCE

The Place of

Philosophy and Science

in the Development of

Knowledge and Understanding

David Culpin

2005

This thesis was submitted by David Culpin

in fulfilment of the requirements of a

Master of Philosophy Degree

at

The University of Sydney

Faculty of Arts

Department of Philosophy

in June 2004,

and resubmitted with emendations in February 2005.

Supervisor: Dr. John Bacon

The author expresses his appreciation of the reading and criticism of this thesis by his supervisor and the referees.

This thesis is printed on acid-free paper.

INTRODUCTION AND SUMMARY

I have been of a philosophical turn of mind since my youth, and following an extended period of work in science, I have been a student of philosophy for a number of years. I have looked to both philosophy and science for fundamental knowledge and understanding of the world and ourselves, and for an understanding of how the various areas of knowledge are established and cohere.

Certainly science obtains fundamental knowledge; and it is reasonably clear how it does so and that scientific knowledge coheres, as its reference to an empirical base and its continuous striving for theoretical unity are inherent in scientific practice. Science itself does not have much to say about its practice though, perhaps because, as Einstein said, "The whole of science is nothing more than a refinement of everyday thinking."[1] It is only the behavioural sciences and philosophy that have much to say about scientific practice.

Turning to philosophy, what does it contribute to our understanding of the world and ourselves? Here I am thinking of the basic philosophical areas of metaphysics and epistemology rather than special areas such as moral philosophy. This is a question that has been a puzzle for me to answer and has thus become the subject of this investigation. Initially I was inclined to the view that philosophy has made a positive contribution to the development of our understanding and knowledge of the world and ourselves, at the very least as an arena of speculative skirmishing preparatory to the entry of science.[2] However, as the investigation proceeded evidence has accumulated that has inclined me to a more critical view of philosophy.

Wilfrid Sellars says that

> The aim of philosophy, abstractly formulated, is to understand how things in the broadest possible sense of the term hang together in the broadest possible sense of the term.[3]

However, Sellars is making an assumption here that can legitimately be doubted, namely that there is a way in which things hang together beyond that which can be discovered by science. Many, especially those with scientific experience, doubt this. One who doubts it is Ronald Giere, a one-time physicist turned naturalistic philosopher of science. He writes:

---

[1] Albert Einstein, "Physics and Reality", p. 59

NOTE ABOUT REFERENCES: Page numbers in a footnote refer to the source from which the quoted material is taken, as indicated in the list of references at the end, unless otherwise indicated.

[2] I do not need to rely on my memory for this, as I have early drafts of this essay stating that view.

[3] Wilfrid Sellars, "Philosophy and the Scientific Image of Man", p. 1

> . . . I now believe there are no special philosophical foundations to any science. There is only deep theory, which, however, is part of science itself. And there are no special philosophical methods for plumbing the theoretical depths of any science. There are only the methods of the sciences themselves. Moreover, the people best equipped to engage in such pursuits are not those trained as philosophers, but those totally immersed in the scientific subject matter—namely scientists.
> . . . The philosophical goal, in short, has been to provide some extrascientific foundation for scientific claims. This project now seems to me merely a modern, secular version of the medieval project of providing philosophical proofs of the existence of God.[4]

This is the view that is maintained in this essay: to attempt to go beyond the empirically based reality obtained through everyday experience and thinking and its scientific refinement and extension to a metaphysical reality which is independent of the human mind is destined to fail. It is destined to fail because belief in the existence of such a reality, going beyond empirical evidence as it does, can only be an act of faith which, like belief in the existence of God, acts as an impediment to productive thought: that is, it leaves us with the illusion of an understanding that we do not possess.

A good example of the tendency of philosophers to by-pass empirical facts is shown in their struggle with the phenomenon of pain, which they have attempted without success to fit into one or another idealized philosophical stereotype. Here is a scientist's summary of these attempts.

> Indeed, a little digging into the philosophical literature uncovers just about every conceivable position regarding what pain is. Some philosophers and neurophysiologists argue that pain is completely objective; it is either intrinsic to the injured body part, a functional state, a set of behavioral reactions, or a type of perception. Some philosophers and psychologists argue that pain is completely subjective; it is either essentially private and completely mysterious, or it does not correlate with any biological markers but is completely non mysterious. A few philosophers disagree with both conceptions and hold that pain is not a state at all; it either does not exist as we commonly conceive of it or it is an attitudinal relation. Furthermore, each of these positions has become grist for someone's mill in arguing either that pain is a paradigm instance of a simple conscious state or that pain is a special case and should not be included in any general theory of the mind.[5]

And here is a philosopher's account of the value his discipline typically places on scientific facts.

> Very few today still believe that philosophy is a disease of language and that its deliverances, due to disturbances of the grammatical unconscious, are neither true nor false but nonsense. But the fact remains that, very often, philosophical theory stands to positive knowledge roughly in the relation-

[4] Ronald N. Giere, *Explaining Science; A Cognitive Approach*, pp. xvi-xvii
[5] Valerie Hardcastle, "The Nature of Pain", p. 295

> ship in which hysteria is said to stand to anatomical truth. Freud said, famously, that hysteria appears to have no knowledge of physiology, for its paralyses and tics, its incapacities and pains, are located by the sufferer where there is no objective possibility of their occurring. Philosophers erase entities in defiance of common sense and postulate entities of which there is not the slightest possibility of scientific confirmation. Parsimonious with one hand and profligate with the other, philosophers behave not only as though they had no knowledge of scientific truth but as if philosophy had its own authority, and not only did not need but could not use information from science.[6]

Evidence of philosophy's failure is clear to everyone: philosophy has hardly progressed toward a resolution of the issues central to it in two and a half thousand years. Most philosophers acknowledge this, but view the failure as a virtue in disguise; or at least two virtues:

Virtue I: Philosophy has a function of stimulating speculative inquiry which often develops into science; or putting it another way, successful philosophy is renamed science; and

Virtue II: There are fundamental philosophical problems that are not addressable by scientific method, namely problems concerning the mind–world relationship.

These two supposed virtues in justification of philosophy are examined in this essay in Parts I and II respectively.

Consider Virtue I, which is almost universally subscribed to. Let us look, for example, to two of the philosophers already quoted. Sellars writes:

> Philosophy in an important sense has no special subject-matter which stands to it as other subject-matters stand to other special disciplines. If philosophers did have such a special subject-matter, they could turn it over to a new group of specialists as they have turned other special subject-matters to non-philosophers over the past 2500 years, first with mathematics, more recently psychology and sociology, and, currently, certain aspects of theoretical linguistics.[7]

Giere also subscribes to this idea:

> There is another philosophical tradition of equal antiquity. This tradition views philosophy simply as the search for a general understanding of the world—including the activities of human beings. It is this tradition that over the centuries gave birth to the special sciences that now dominate the intellectual world.[8]

In Part I the idea that philosophy stimulates science is investigated historically

[6] Arthur C. Danto, foreword to C.L. Hardin, *Color for Philosophers*, p. ix

[7] Sellars, *op. cit.*, p. 2

[8] Giere, *op. cit.*, p. xvii

(neglecting historiographic considerations, which would not contribute to the investigation), and the conclusion reached is that the idea is a philosophical myth. Science is stimulated by certain socio-political conditions, principally freedom of the individual from religious and undue political domination, a reasonable level of economic well-being, the stimulus of intercultural contact, and the development of technology as an accepted means to economic advancement. These conditions, apart from the last, were approached temporarily in ancient Greece, especially in the pre-Socratic period, though not closely enough for a sustained development of science; they were realized briefly in Renaissance Italy prior to the sentencing of Galileo by the Inquisition, and then to a sufficient extent in post-Reformation north-western Europe and Great Britain to bring about the sustained development of science that we have witnessed since that time. Rather than philosophy stimulating science, it was science, both incipient and developed, as well as the conditions that lead to it, that acted as the stimulus for philosophy, while whatever influence philosophy has had on science has in most cases acted as an impediment to its creative spirit. Science is not mature philosophy, but is a quite distinctive development.

Now consider Virtue II, that there are special philosophical problems concerning the mind–world relationship that are not addressable by science. Are there are such problems? We note certain facts relevant to their purported existence.

(a) There is no agreed observational or suppositional base for these problems. Philosophers often say that philosophy is hard. It is certainly not hard in the way that theoretical physics is hard: physics is hard to invent, but it is relatively easy to express because it is clear what it is about; philosophy is easy to invent, but is hard to express because it is not clear what it is about, or that it is about anything. It is not clear what philosophy is about because, unlike physics, it has no agreed observational or suppositional base—the base itself is often considered a philosophical issue. It is also not clear what it is about because much of it is based upon aspects of introspectively acquired notions that are not objectively communicable. Lack of an agreed observational base, or absence of one, assuredly removes a problem from scientific consideration. And, one might add, it removes it from *any* systematic consideration—what *is* the philosophical problem of consciousness?

(b) Philosophy appears to attempt little more than a speculative ordering of our common experience, which is the limit of its observational base, thus reflecting the idiosyncrasies of our animal constitution and our local environment, natural, cultural and scientific. This is in sharp contrast to science, which develops the ordering of experience by extending experience itself beyond the constraints of our natural endowment and environment. Thus philosophy seeks to interpret the world in terms of the human mental constitution and human interests; or, as such interpretation must be communicated in everyday language, philosophy is concerned with how to talk about things, not with examining things themselves in the scientific way. Granted that seeking interpretations of our experience in everyday language is what philosophy is concerned with, it is easily seen how any philosophical proposal to this end cannot be amenable to scientific practice and is destined to fail: common, or common philosophical, language is not the medium in which such interpretations are expressible, because such a language does not possess the references that are required for effective interpretation, namely the scientific references from which fundamental knowledge derives. This aspect of philosophy also shows how its influence can act as an impediment to the creative spirit of science, for scientific creation requires the development through empirical reference of concepts with which philosophy is unfamiliar and is in consequence inclined to oppose.

(c) It is maintained that some philosophical problems are inherently insoluble, not for the reasons given in (a) and (b), but because of inherent limitations in our capacities, or as McGinn terms it[9], because such problems are "cognitively closed" to us. An example is the current philosophical interest in the philosophical "hard problem" of consciousness, which has been stimulated by the comparatively recent general acceptance of the fact that we are purely physical structures, rather than dualities of mind and matter: how could the conscious awareness that we experience arise from our purely physical structure? As the problem in the form presented arises purely on the basis of introspection—for none of us can ever know another's consciousness in the sense of the hard problem of consciousness—there is no objective observational base to which the problem may be referred. A cognitively closed problem is not so much philosophically insoluble as philosophically unformulated.

In none of cases (a), (b) or (c) can there be found a philosophical problem that is not addressable by science.

In Part II of this essay an attempt is made to show that all philosophical problems concerning the mind–world relationship are either amenable to scientific investigation and analysis or are not substantial problems at all. This is done by setting out a minimal description of the facts that both accommodates the scientific perspective and enables philosophical concerns with the mind–world relationship to be dissolved. This addresses (a) by providing an observation base that, consonant as it is with known facts, cannot be denied, and that gives an essential role to subjective experience, and it addresses (b) by recognizing aspects of the mind–world relationship that lie beyond familiar

---

[9] Colin McGinn, *The Problem of Consciousness*, p. 3

experience. A by-product of this procedure is the dissolution of the problems relating to subjective experience, namely the problem of qualia and the hard problem of consciousness.

As a result of the analysis of Part II, it is maintained that there are no essentially philosophical problems.

If this thesis seems unduly clear to a philosopher (clearly wrong?), then he must have misunderstood what it says.[10]

[10] With acknowledgement to Alan Greenspan, as reported in *The Economist*, March 27th, 2004, p. 18

PART I: Does Philosophy Lead to Science?

1. Introduction

Summary: *The aim is to investigate the part played by philosophy in the acquisition of knowledge and understanding, both in association with and independently of science. Only non-normative philosophy is considered.*

This essay is concerned to discover the role of philosophy in the acquisition of knowledge and understanding. The acquisition of knowledge and understanding is a process that has underlain the development of civilization for the last two and a half thousand years, with notable acceleration in the last four hundred years. It is therefore relevant to look at the historical record to see what part philosophy has played in this process. As the advent of science is central to modern developments, the interaction of philosophy with science is of particular relevance to the issue, as also are claims that philosophical enquiry gives access to knowledge that is closed to science.

Philosophy is a broad discipline with pliant boundaries. On one side it could be envisaged as bounded by science, on another side by ethics, on another aesthetics, and on a fourth side by history and politics. All but the first of these categories are to be thought of as concerning normative issues. Thus 'ethics' here means normative ethics, concerned with what is good and bad, in contrast with meta-ethics, the analysis of moral issues, which is near the boundary with science and might be informed by a study of anthropology for example. Also adjoining science are the philosophy of science, the philosophy of history, and so on. This essay is concerned primarily with the vicinity of the philosophy–science boundary. Philosophy could once have been said to occupy most of the field of knowledge and understanding, but as the observational underpinnings of intellectual enquiry have developed philosophy has come to occupy a diminishing central region, proportionally diminished by the growth of science.

2. Does Philosophy Lead to Science?

Summary: *The idea that science emerges from philosophy is questioned. Did not the scientific revolution free thought from the shackles of Aristotelianism*?

Many, particularly philosophers, see the acquisition of knowledge by science as a process in which philosophy shows the way, or at least provides the basic structure for scientific thinking, thus giving philosophy an important part of its justification as a discipline. John Searle, for example, writes:

> 'Philosophy' is in large part the name for all those questions which we do not know how to answer in the systematic way that is characteristic of science. These questions include, but are not confined to, the large family of conceptual questions that have traditionally occupied philosophers: what is truth, justice, knowledge, meaning, and so forth. For the purposes of this discussion [about the scientific study of consciousness] the only important distinction between philosophy and science is this: science is systematic knowledge; philosophy is in part an attempt to reach the point where we can have systematic knowledge. This is why science is always 'right' and philosophy is always 'wrong': as soon as we think we really know something we stop calling it philosophy and start calling it science. Beginning in the seventeenth century, the area of systematic knowledge, that is, scientific knowledge, increased with the growth of systematic methods for acquiring knowledge.[11]

One could take exception to Searle's characterization of science as systematic in its method of acquiring knowledge: what characterizes science is its method (if that is an appropriate name for it; 'scientific practice' might be more appropriate), not just that it is systematic in applying it. For philosophy is also systematic in applying method, though perhaps not a method of acquiring knowledge so much as a critical method that may or may not facilitate the acquisition of knowledge. Concerning Searle's claim about philosophy leading to science, it can at least be allowed that foundational stages of enquiry have often been accepted as falling partly within the province of philosophy. For example, Aristotle's physics is best regarded as a philosophical precursor of mechanics. But was it (in Searle's words) an attempt, even in part, to reach scientific knowledge? That does not appear to have been its aim, and it is generally accepted that Aristotle's physics and cosmology impeded the development of science more than it helped.

However, this example gives a negative evaluation of philosophy only if Aristotle's physics and cosmology can rightly be called philosophy and Galileo's physics and cosmology called science. William James makes this general observation:

> It is obvious enough that if every step forward which philosophy makes, every question to which an accurate answer is found, gets accredited to science the residuum of unanswered problems will alone remain to constitute the domain of philosophy, and will alone bear her name.[12]

This differs slightly from Searle's claim. Whereas Searle imagines scientists taking philosophers' ideas and turning them to scientific use, James, philosopher–scientist that he was, imagines philosophers themselves turning the ideas to scientific use, and thereupon being called scientists. As we know, in this world there is amongst unexamined propositions as much myth as fact,

---

[11] John R. Searle, "How to Study Consciousness Scientifically", p. 20

[12] William James, *Some Problems of Philosophy*, p. 22

and to expose myth we must seek out its factual reference, if any. James refers to Galileo, whom he describes as a philosopher in the original sense of the word, a universal sage, and quotes Galileo in support of this description: "Galileo said that he had spent more years on philosophy than months on mathematics."[13] If Galileo implied by this that he was himself a philosopher, he certainly did not mean that he was a universal sage, but could only have meant that he was a natural philosopher, that is, a physicist. But it is more likely that Galileo was referring to the years it took him to free himself from the unproductive, teleological, Aristotelian approach to science in which he was schooled and which he first taught, and to his years in dispute with the entrenched Aristotelian philosophers who opposed him after he had freed himself of it. And by 'mathematics' Galileo no doubt meant the mathematical study of motion that he inaugurated as one of the first scientists in the modern sense, where mathematical description yields precise prediction—the book of nature is written in the language of mathematics, he said. As an example of his dispute with Aristotelians, when a new astronomical body appeared in the sky in 1604, Galileo established that it showed no parallax, implying that it could not have been a sublunar phenomenon, but must have belonged to the celestial sphere. This contradicted Aristotle's principle that change cannot occur in the celestial sphere, where things are composed of an unchanging substance called quintessence, unlike the sublunar region, including the earth, which is constituted by the four elements, earth, water, air and fire. Cremonini, the professor of philosophy at Padua, wrote in defence of Aristotle (or at least Aristotle as interpreted for the Catholic Church by Thomas Aquinas) that ordinary measuring processes do not apply to the celestial sphere. Galileo, who was professor of mathematics at Padua,

> . . . replied by publishing (over an assumed name) a little dialogue between two peasants, written in rustic Paduan dialect, in which he made a peasant reason better than the celebrated professor. . . . Galileo's peasant spokesman asked what philosophers knew about measuring anything. It was the mathematicians, he said, who had to be trusted in measurements, and they did not care whether the thing seen was made of quintessence or polenta, because that could not change its distance.[14]

Can this activity of Galileo be accurately and fairly described, as Searle might have it, as a scientist turning philosophical ideas to scientific use, or as James would like to see it, as a philosopher making a step forward in philosophy but with science taking the credit? The facts are quite clear: Galileo's achievement was not a development within a prevailing philosophy; on the contrary, it formed a major part of the scientific revolution of the seventeenth

---

[13] James, *op. cit.*, p. 21

[14] Stillman Drake, *Galileo*, p. 39

century, whereby man at last began to free himself from the shackles of a two thousand year old philosophical system by means of a completely new way of looking at things, which was to look to the observable facts and see what empirical laws they may exemplify. Galileo's discoveries are called scientific and not philosophical because they *are* scientific and not philosophical, because Aristotle and Galileo belonged to entirely different traditions, with different aims and different methods of approach. It is these differences that underlie and epitomize the difference between philosophy and science.

In defence of this thesis, could James have pointed to Galileo's use of mathematics as a scientific development of Pythagorianism? It is unlikely that James would have done so, as his quotation was of Galileo's *contrasting* philosophy with mathematics. In any case, Pythagoras's idea was that numbers are the basic stuff of the world, whose structure can be discovered by mathematical thought alone, and this was not a philosophical idea with a scientific future, as Plato's and Kepler's attempts to make something of it illustrate.

Perhaps James chose his example unwisely; for have there not been many subsequent cases of philosophy leading on to science, for instance the atomic theory of the Greeks leading eventually to the modern atomic theory of physics and chemistry? To understand the mutual development of philosophy and science we need to investigate the historical record, and as philosophy and science do not exist in isolation from other historical and social movements, it is necessary to take those movements into account. There are two important movements intimately associated with philosophy and science whose inclusion in any enquiry enable some insight to be obtained into their relationship, namely religion in connection with philosophy and technique in connection with science.

3. Comte's Account of Scientific Development

Summary: *Comte's Law of development through the theological, metaphysical and scientific states is examined. Comte finds the origin of science in philosophy, but does not explain how philosophy arises or how science emerges from philosophy. He takes no account of the origins of science in technique.*

It is useful to begin with an account of the sequential development of religion, philosophy and science put forward by Auguste Comte in 1822. He proposed a "fundamental Law, to which the mind is subjected by an invariant necessity", according to which mankind progresses through the three states, Theological, Metaphysical (philosophical) and Positive (scientific).

> 5. In the Theological state, the human mind directs its researches mainly towards the inner nature of beings, and towards the first and final causes of all the phenomena which it observes—in a word, towards Absolute knowledge. It therefore represents these phenomena as being produced by the di-

> rect and continuous action of more or less numerous supernatural agents, whose arbitrary intervention explains all the apparent anomalies of the universe.
>
> 6. In the Metaphysical state, which is in reality only a simple general modification of the first state, the supernatural agents are replaced by abstract forces, real entities or personified abstractions, inherent in the different beings of the world. These entities are looked upon as capable of giving rise by themselves to all the phenomena observed, each phenomenon being explained by assigning it to its corresponding entity.
>
> 7. Finally, in the Positive state, the human mind, recognising the impossibility of obtaining absolute truth, gives up the search after the origin and destination of the universe and a knowledge of the final causes of phenomena. It only endeavours now to discover, by a well-combined use of reasoning and observation, the actual *laws* of phenomena—that is to say, their invariable relations of succession and likeness. The explanation of facts, thus reduced to its real terms, consists henceforth only in the connection established between different particular phenomena and some general facts, the number of which the progress of science tends more and more to diminish.[15]

Observe that when Comte refers to 'the human mind' he is thinking of the collective mind, as embodied in a culture; and when Comte speaks of progress toward a positive state, he is thinking of the development within a culture of a state not already known to it as fully developed elsewhere, of participation in the creation of science.

Comte likens philosophy to religion with its supernatural causal agents replaced by abstract causal agents, and in their all encompassing forms, with God replaced by Nature. Explanation for both religion and philosophy is teleological, where 'cause' means final cause (in Aristotle's terminology). In the Positive state explanation is no longer teleological, final cause having been replaced by efficient cause, where action is as described by scientific laws; for as Comte writes:

> Man gradually accustomed himself to consider only the facts themselves. In that way, the ideas of these metaphysical agents gradually became so dim that all right-minded persons only considered them to be the abstract names of the phenomena in question. It is impossible to imagine by what other method our understanding could have passed from frankly supernatural to purely natural considerations, or, in other words, from the Theological to the Positive *Régime*.[16]

Just as in the highest forms of religion and philosophy multiple causal agents are replaced by the single causal concepts of God and Nature, in the Positive state a multiplicity of unconnected natural laws tend to be reduced to a unified system of laws, a general theory:

---

[15] Auguste Comte, *Course in Positive Philosophy*, §§5-7

[16] Comte, *op. cit.*, §21

> . . . the ideal of the Positive system, towards which it constantly tends, although in all probability it will never attain such a stage, would be reached if we could look upon all the different phenomena observable as so many particular cases of a single general fact, such as that of Gravitation, for example.[17]

How do natural laws and the theories that subsume them arise? After noting that "All competent thinkers agree with Bacon that there can be no real knowledge except that which rests upon observed facts", Comte writes of the function of "Theological conceptions" that

> . . . there were two difficulties to be overcome: the human mind had to observe in order to form real theories, and yet had to form theories of some sort before it could apply itself to a connected series of observations. The primitive human mind, therefore, found itself involved in a vicious circle, from which it would never have had any means of escaping, if a natural way out of the difficulty had not fortunately been found by the spontaneous development of Theological conceptions. These presented a rallying point for the efforts of the mind, and furnished materials for its activity. This is the fundamental motive which demonstrates the logical necessity for the purely Theological character of Primitive Philosophy . . .[18]

Consequently, of the functions of "Metaphysical conceptions" he writes:

> 21. It is easily seen that our understanding, which was compelled to progress by almost insensible steps, could not pass suddenly, and without any intermediate stages, from Theological to Positive philosophy. Theology and Physics are so profoundly incompatible, their conceptions are so radically opposed in character, that, before giving up the one in order to employ the other exclusively, the human intelligence had to make use of intermediate conceptions, which, being of a hybrid character, were eminently fitted to bring about a gradual transition. That is the part played by Metaphysical conceptions, and they have no other real use.[19]

Comte fits his theory to the historical record by selecting for the inauguration of the Positive state,

> . . . the great movement imparted to the human intellect two centuries ago [1620's], by the combined influence of the precepts of Bacon, the conceptions of Descartes, and the discoveries of Galileo. It was then that the spirit of the Positive Philosophy began to assert itself in the world, in evident opposition to the Theological and Metaphysical spirit; for it was then that Positive conceptions disengaged themselves clearly from the superstitious and scholastic alloy, which had more or less disguised the true character of all the previous scientific work.[20]

Perhaps Comte includes Descartes because he was a fellow countryman, for

---

[17] Comte, *op. cit.*, §8

[18] Comte, *op. cit.*, §15

[19] Comte, *op. cit.*, §21

[20] Comte, *op. cit.*, §28

despite his mathematical orientation Descartes was more philosopher in the Aristotelian mould than scientist in the Galilean[21], believing that he could find the truth about the physical world in his own mind on only casual acquaintance with it, and of whose major scientific work, *The Principles of Philosophy*, Hall writes:

> The *Principles* was a triumph of fantastic imagination which happens, unfortunately, never once to have hit upon a correct explanation. . . . the *Principles of Philosophy* sorely tried the patience of more empirically minded scientists even in the next generation. . . . But Descartes had cheated. He had not consulted their laborious notebooks nor had he really faced the intricacies of any single phenomenon of nature. He had failed to tie theory . . . to the detailed facts of investigation; he had not even attempted to do so. Nor had he scrupled—this perhaps worst of all—to feign hypotheses which he did not believe to be true in order to fabricate an explanation. And his pretence of geometrical certainty ("I wish nothing to be taken for truth but that which is deduced with so much rigour that it could serve as a demonstration in mathematics") was by this fact alone made farcical. Descartes, in short, was so imaginative a theorist that he had jeopardized the principles of explanation and the very metaphysics which seemed valid to the empiricists themselves, by elaborations only too patently false.[22]

Comte's thesis is a good starting point for an investigation of the development of knowledge and understanding, for it is strikingly modern in many of its ideas: for example, its recognition that effective observation depends on the pre-existence of theory, which itself cannot come into existence without prior observation. On the other hand, Comte's personification of 'the human mind', and his account of its struggle to escape the vicious theory–observation circle reads like the teleology of Aristotle. Comte's account is historicist: his 'Law' 'explains' as inevitable only the developments which it describes, but not why modern science arose only in Western Europe, why philosophy arose only in ancient Greece, why nascent Greek science did not survive its birth, or why Rome had no original philosophy or science.

Of the factors that contribute to the rise of science, Comte identifies only one, the speculative source of scientific theory, which he says is religion via philosophical speculation. Here he is promulgating the same myth that Searle and James subscribe to. It is not true that science necessarily draws its first inspiration from philosophy, for often, as noted above, science has to struggle to free itself from philosophical preconception. Nor is it true that there is a vicious theory–observation circle. The ready identification of vicious circles is a destructive philosophical practice, due to too narrow a focus on causal influ-

---

[21] "Descartes, born to uncover the errors of antiquity, and to substitute his own."—Voltaire. "If I err, I exist."—St. Augustine. From Bernard Pullman, *The Atom in the History of Human Thought*, p. 157

[22] A. Rupert Hall, *From Galileo to Newton*, p. 120-122

ence and too rigid an interpretation of language, on the construction of over simplified formal models—the world is far more complex than any philosopher ever dreamt of. The truth is that science obtains its theoretical ideas from wherever it can—from the resources of science, from technical practice, from commonly accepted concepts (which may or may not be influenced by philosophy)—which it then gradually refines in the light of developing empirical and theoretical knowledge. The influence of philosophy and religion often run counter to this by binding concepts in a formal straightjacket. Here is the view of Richard Feynman, a leading modern physicist:

> People may come along and argue philosophically that they like one [alternative theory] better than another; but we [physicists] have learned from much experience that all philosophical intuitions about what nature is going to do fail. One just has to work out all the possibilities, and try all the alternatives. . . . philosophically you like them or do not like them; and training is the only way to beat that disease.
> . . . mathematics is a deep way of expressing nature, and any attempt to express nature in philosophical principles, or in seat-of-the-pants mechanical feelings, is not an efficient way[23]

What is not clear from the above quotations from Comte is that Comte's concept of 'positive philosophy' is a quite circumscribed version of the modern concept of science, for it contains only facts and empirical laws (despite Comte's reference to theory), and eschews anything that could be interpreted as at all metaphysical (including the atom: see Section 9). It is probably for this reason that Comte relegates the essential heuristic element of science to philosophy rather than recognizing it as part of science itself.

4. Aristotle to Newton: Science Leads the Way

Summary: *Philosophical truth is conformity to philosophical precepts, which reflect either superficial observation or previously accepted scientific theory. Mathematical truth is conformity to facts or to summary laws. With the Aristotelian cosmology, mathematical truth was in service to philosophical truth—the facts had to fit the theory. From Aristotle to Newton mathematical truth gradually took control, with philosophical truth following unwillingly behind.*

At this point it is convenient to return to the differences noted earlier between science and philosophy as epitomized by the different approaches of Galileo and Aristotle. This difference is as old as the dual cosmological systems of Aristotle and Ptolemy. Indeed it is older, as such a duality existed with the Babylonians, who on the one hand had a mythological account of the creation of the world and the heavenly abode of the gods and the earthly abode of man, and on the other hand had an extensive record of astronomical observations

---

[23] Richard Feynman, *The Character of Physical Law*, pp. 53, 57

from which they were able to predict lunar and solar eclipses with some accuracy without knowing anything about the solar system and without reference to their cosmological mythology. In the dual systems of Aristotle and Ptolemy, Aristotle was concerned with what has been called philosophical truth. This means that his cosmological system was required to conform at its inception to his total theory of the world, with his theory of natural motion, whereby objects move to their natural abode, with the doctrine of the four elements, and so on. This system was not mathematical, in fact it did not arise in response to any detailed observation, and thus it possessed no predictive power, apart from conformity to everyday superficial observation. On the other hand, the Ptolemaic system was concerned with quantitative description of the observable, with what is called mathematical truth, with 'saving the phenomena', as it was phrased. This system was a mathematical construction conforming broadly with Aristotle's cosmology and with Plato's geometric idealism, elaborated with additional mathematical constructs (epicycles etc.) so as to yield a reasonably precise predictive capability, which was its sole object. In the duality of Aristotle and Ptolemy we see a primitive progenitor of modern science, a pre-scientific system, comprising theory on one side and technique on the other. In mature science there is a continual interaction between theory and technique, while here there is a rigid conformity of technique to theory, theory being pure philosophy, drawing its inspiration largely from mythology but virtually nothing from technique. Please refer to Figure 1 at the end of Part I for a graphical depiction of these connections.

From the point of view of mathematical truth, the conformity of the Ptolemaic system to patterns insisted on for philosophical truth could be put aside without loss, and if gain in mathematical understanding could be achieved by doing so, there would be an incentive to do it. Gain in mathematical understanding was the main driving force behind Copernicus's change from an earth centred to a sun centred planetary system, and when eventually the overwhelming mass of evidence forced philosophy to conform to technique, we are witness to the birth of modern science. But at the time of Copernicus the evidence was far from overwhelming, and his change to a sun centred planetary system was more likely to be seen as posing a direct threat to philosophical truth as promulgated by the religious establishment, unless, of course, it could be presented as motivated by no more than the pursuit of mathematical convenience. Here was presented

> . . . an ineluctable dilemma: is the supposed motion of the earth a mathematical fiction or does Copernicus maintain that the earth is not immobile in the centre of the world, but revolves on its axis as well as about the sun?
>
> The first readers of *De Revolutionibus* had no cause to be alarmed about this dilemma, for the work itself is preceded by a preface, entitled *To the*

> *Reader, About the Hypothesis of This Work*, in which it is stated that the author merely wished to accomplish the task of an astronomer, namely to make it possible to calculate the celestial motions with the aid of hypotheses, but that the formulation of such hypotheses by no means implies the assertion that they are true [*i.e.* philosophically true], nor even that they are probable. Astronomy cannot provide any certainty on this point; whoever takes for truth the suppositions it has made for a different purpose will leave this science a greater fool than he was when he started.[24]

This preface was written not by Copernicus but by a Lutheran theologian, Andreas Osiander, in order to forestall possible controversy. It is not clear whether Copernicus would have approved the preface: no doubt there would have been a dilemma for him too had he been confronted with the need to decide where the truth lay, for as a canon of the Church his world view was anchored in Aristotelian church dogma, while as an astronomer he was inevitably drawn to a perception dictated by mathematical exigency. What we see in the case of Copernicus is a change driven entirely by considerations internal to astronomical and mathematical technique and in opposition to philosophical/religious dogma. Fortunately for Copernicus the Church at that time, and for the next sixty years, was accommodating of both philosophical and mathematical truth, as long as they did not interact, thus allowing Copernicus's revolutionary transformation to become known in the astronomical community, even though it was generally accepted only as a technical development.

As a result of the Protestant Reformation and the ensuing increased activity of the Catholic Inquisition, by the time Galileo had reached middle age the Church was much less inclined to be so accommodating of dissent. Had Galileo followed the advice of Cardinal Bellamine to

> . . . treat the Copernican system *ex suppositione*, *i.e.* merely to assert that the planetary phenomena can be saved more easily by taking the sun as centre of the world rather than the earth[25]

Galileo would no doubt have avoided direct confrontation with the Church. But Galileo, who was more physicist than astronomer, could, and did, argue for the Copernican system from both the physical and astronomical points of view—it was he who was first able to effectively answer some of the main physical objections to a non-stationary earth by the introduction of a non-Aristotelian physics. He could not, therefore, bring himself to accept the old formula that the Copernican system was philosophically false though mathematically true; for him, philosophical truth meant physical truth as he conceived of physics—the earth really did move. Hence Galileo's eventual con-

---

[24] E.J. Dijksterhuis, *The Mechanization of the World Picture*, p. 296

[25] Dijksternhuis, *op. cit.*, p. 385

frontation with the Inquisition. Philosophical truth was gradually catching up with mathematical truth.

As a result of the persecution of Galileo, the centre of scientific development moved to north-western Europe, and by Newton's time Aristotelian cosmology had been superseded by Kepler's mathematical refinement of Copernicus, while physics had still to free itself completely from its Aristotelian precepts. Descartes's *The Principles of Philosophy* (referred to earlier, Section 3) gives a good representation of the state of philosophical truth about this time. First, in Descartes one finds the same reliance on intuitive insight as a source of truth as one finds in Aristotle. Second, Descartes subscribed to the Aristotelian tenets that an absolute vacuum is impossible (conceptually and therefore physically), and that physical influence between inanimate bodies is possible only through immediate contact. He therefore postulated vortices of infinitely divisible particles as a medium for transmitting influence between bodies separated by apparently empty space, such as planets, and streams of screw-like particles for transmitting magnetic attraction and repulsion. Third, Descartes adopted and modified Galileo's concept of inertia, proposing that a body move at constant speed in a straight line unless acted upon by another body. This principle of inertia was later adopted by Newton for his first law of motion. However, according to Descartes, a body's motion is impeded by the particles that fill space, resulting in the circular inertial motion assumed by Galileo. Fourth, Descartes believed, with Galileo, that mathematics is the key to scientific truth. But he did not believe this in the way Galileo did: for Galileo mathematics is the *language* of science, the means for its expression; for Descartes the world is a purely geometric construct—matter is extension—a view which derives from Plato, and ultimately from Pythagoras, and is closely associated with the first feature of Descartes's philosophy, his reliance on intuitive insight. Descartes represents the philosophical truth of his time, and his influence was such, except in England, that it remained dominant long after Newton had shown that most of Descartes's scientific notions were false.

Newton's foremost achievement was the establishment, on observational grounds, of a unified system of dynamics combining a universal law of gravitational attractive force between any two bodies with laws of motion applicable to any body subject to a force. This system was also unifying, accounting for an extraordinary range of physical phenomena in the universe, from planets to earth-bound projectiles, from the tides to the shape of the earth. Newton's process of discovery was, in a basic simplified form, as follows. By likening the orbit of the moon to the path of a projectile launched from the earth at just sufficient speed as not to return to the earth's surface, Newton first came to understand the unity of planetary and local motion. Thus the same gravitational attraction applies to planets as to earth-bound objects, so planets as well as earth-bound objects undergo acceleration in the direction of an attractive force. Thence, combining a gravitational attractive force of unspecified form with an extended law of inertia (Newton's second law of motion), whereby force is defined as proportional to acceleration, and applying this to the planets so as to accommodate Kepler's second and third laws of planetary motion, Newton obtained a law of gravitational attractive force between any two bodies which is inversely proportional to the square of the distance between their mass centres, and conversely can be used to derive a more accurate version of all three of Kepler's laws than Kepler himself stated. Thus Newton writes:

> Hitherto we have explained the phenomena of the heavens and of our sea by the power of gravity, but have not yet assigned the cause of this power. This is certain, that it must proceed from a cause that penetrates to the very centres of the sun and planets, without suffering the least diminution of its force; that operates not according to the quantity of the surfaces of the particles upon which it acts (as mechanical causes are want to), but according to the quantity of solid matter which they contain, and propagates its virtues on all sides to immense distances, decreasing always as the inverse square of the distances. Gravitation towards the sun is made up of the gravitations towards the several particles of which the body of the sun is composed.[26]

Like many a great discovery, once made it can readily be comprehended, because most of the component parts were already in the scientific community, there for the assembling so to speak, though not all quite in the form required, and accompanied by many superfluous components with the potential to confuse the process of discovery unless confidently rejected, these latter being principally those incorporated into Descartes's *Principles*.

Newton's achievement owed almost nothing to the philosophical truth of his time, and was contrary to it in its central idea of gravitational attraction, for, as is clearly stated by Newton (quoted above), it postulated influences acting at distances of unlimited extent across empty space, contrary to the philosophically correct Aristotelian physical principles adopted and promulgated by Descartes. Science was now leading philosophy in a new direction.

5. Reactions to Newton

Summary: *Newton's physics was at first regarded as mathematically true, but philosophically false. But as its fecundity became apparent, it assumed the mantle of philosophical truth, with attendant attempts to show it to be true a priori.*

How can one make philosophical sense of such a theory as Newton's? Newton himself at first found it unsatisfactory, but was unable to find an explanation;

[26] Isaac Newton, General Scholium to *Principia*, Book III

hence his famous statement *Hypotheses non fingo*[27]:

> But hitherto I have not yet been able to discover the cause of those properties of gravity from phenomena, and I frame no hypotheses; for whatever is not deduced from the phenomena is to be called an hypothesis; and hypotheses, whether metaphysical or physical, whether of occult qualities or mechanical, have no place in experimental philosophy.[28]

By this Newton meant that he made no proposal as to philosophical truth, as Descartes had done, merely as to mathematical truth—and hence the title of his work, *Philosophiae Naturalis Principia Mathematica*, *The Mathematical Principles of Natural Philosophy* (compare Descartes's *The Principles of Philosophy*). The distinction is expressed unambiguously by Berkeley:

> As for attraction, it was certainly introduced by Newton, not as a true, physical quality, but only as a mathematical hypothesis. . . . to be of service to reckoning and mathematical demonstrations is one thing, to set forth the nature of things is another.[29]

Keith Campbell claims that

> Many a scientist, Newton included, hoped that one day gravitation would be shown to be (that is, reduced to) a complicated set of collisions, on the ground that action at a distance was impossible.[30]

But what of the nature of collision? Newton later speculated that collision could itself be reduced to action at a distance:

> Have not the small Particles of Bodies certain Powers, Virtues, or Forces, by which they act at a distance, not only upon the Rays of Light for reflecting, refracting, and inflecting them, but also upon one another for producing a great Part of the Phænomena of Nature?[31]

Faced with the phenomenal success of a theory in opposition to many prevailing philosophical precepts, what reaction might be expected from the philosophical establishment? Newton's fellow countrymen were on the whole more accepting of his theory than Continental Europeans. Locke, who prior to Newton's *Principia* had written that bodies interact by impulse and nothing else, changed his mind:

> It is true I say that bodies operate *by impulse, and nothing else*. And so I thought when I wrote it; and can yet *conceive* no other way of operation. But I am since convinced by the judicious Mr. Newton's incomparable book, that it is too bold a presumption to limit God's power on this point by my narrow conceptions. The gravitation of matter towards matter, by ways inconceivable to me, is not only a demonstration that God can, if he pleases, put into

---

[27] *non fingo*: I do not fashion, frame, feign, invent

[28] Isaac Newton, General Scholium to *Principia*, Book III

[29] George Berkeley, *De Motu*, Section Section 17-18

[30] Keith Campbell, *Metaphysics, An Introduction*, 1975, p. 101

[31] Isaac Newton, *Opticks*, Book 3, Query 31

> bodies powers, and ways of operation, above what can be derived from our idea of body, or can be explained by what we know of matter, but is also an unquestionable and everywhere visible instance that he has done so. And therefore, in the next edition of my book, I shall take care to have that passage rectified.[32]

An appeal to God alone (or any vague abstraction) can establish nothing—or anything, according to one's disposition and ingenuity: but to get onto firm ground one needs to appeal to God's facts, as Locke was prepared to do. The lingering influence of Descartes is illustrated by Leibniz, of whose rejection of action at a distance Russell ascribes to a Cartesian prejudice.[33] Leibniz's rejection of Newton is supported by his following intemperate remarks.

> Thus we see that matter does not naturally have the attraction mentioned above, and does not of itself go in a curve, because it is not possible to conceive how this takes place, that is to say, to explain it mechanically, whereas what is natural ought to be able to be rendered distinctly conceivable, if we were admitted into the secrets of things. This distinction between what is natural and explicable and what is inexplicable and miraculous removes all the difficulties: in rejecting it we should be upholding something worse than occult qualities, and in so doing we should be renouncing philosophy and reason, and throwing open sanctuaries for ignorance and idleness, by a stupid system which admits not only that there are qualities which we do not understand (of which there are only too many), but also that there are some which the greatest mind, even if God provided him with every possible advantage, could not understand—that is to say they would be either miraculous or without rhyme or reason. It would indeed be without rhyme or reason that God should perform miracles in the ordinary course; so that this do-nothing hypothesis would destroy equally our philosophy which searches for reasons, and the Divine wisdom which provides them.[34]

That the rejection derived from a Cartesian prejudice is explained in Leibniz's correspondence with Clarke.

> For it is a strange fiction to regard all matter as having gravity, and even to regard it as gravitating towards all other matter, as if every body had an equal attraction for every other body in proportion to mass and distance; and this by means of attraction properly so called, and not derived from an occult impulsion of the bodies. Whereas in truth the gravitation of sensible bodies towards the centre of the earth must be produced by the movement of some fluid. And the same is true of other gravitations such as those of the planets towards the sun or towards one another. A body is never moved naturally except by another body which impels it by touching it; and after this it goes on until it is hindered by another body touching it. Any other op-

---

[32] John Locke, *Essay Concerning Human Understanding*, Book II, Chap. VIII, Section 11, footnote 1

[33] Bertrand Russell, *A Critical Exposition of the Philosophy of Leibniz,* p. 93

[34] G.W. Leibniz, *New Essays on the Human Understanding*, p. 169

eration on bodies is either miraculous or imaginary.[35]

As, in matters amenable to the scientific approach, it is apparently not the role of philosophy to lead the way, then, perhaps, its role is rather to follow on, tidying up the logical loose ends, subjecting it to critical analysis in the Socratic manner, or showing that the brilliant achievements of science are after all inevitable products of the human mind. Philipp Frank offers the following description of how philosophy followed on.

> But presently the confirmation of these principles by the increasing range of physical facts that could be derived from them changed the attitude of the philosophers too. If we examine the general opinion toward the end of the eighteenth century we notice a complete revolution. The law of inertia and the law of gravitation were no longer regarded as absurd; on the contrary, they were declared more and more to be self-evident, derivable from pure reason, the only way in which the human mind can understand nature.
>
> As an example of this changed attitude we can point to Immanuel Kant's "Metaphysical Elements of Natural Science", which was published in 1786. We find in this book all the theorems of Newton's *Mathematical Principles of Natural Philosophy*, but they are transformed, so to speak, into a petrified state. Newton had invented bold generalizations in order to cover a large range of facts that had formerly defied all attempts at rational approach. All these general statements, which seemed to Newton's contemporaries so new, so amazing, so absurd, are now quoted as self-evident. Kant claimed to have demonstrated that the law of inertia can be derived from pure reason; he claimed that the recognition of that law is the only assumption under which nature is conceivable to human reason.[36]

6. Philosophy Rationalizes Science

Summary: *A priori demonstrations of Newton' physics rest partly on an assumed a priori principle of causation. While causation may be a presupposition of modern science, it is not an a priori principle, but is empirically established, having come into full use only with the failure of earlier non-causative principles. The basic human tendency is to seek explanation, whether causal or otherwise. Attempts of philosophers to rationalize science are of no value, and can only impede its development. A mature science develops from its own resources. The mark of a scientific proposition is the openness of its proponents to its falsification.*

The fact that it took two thousand years to discover that one of the keys to a successful mechanical description of nature is the law of inertia, and that it was then discovered by the scientific enterprise, does not of course preclude that it may be derived from pure reason, or that it may be discovered in one's mind by a minimal prompting from empirical reality in the manner of the

---

[35] G.W. Leibniz, *Correspondence with Clarke*, Fifth Paper, Section 35

[36] Philipp Frank, "Why do scientists and philosophers so often disagree about the merits of a new theory?", p. 212

slave boy's recollection of geometry in Plato's *Meno*.

Kant was not the first to propose a derivation of the law of inertia on an *a priori* basis: Jean le Rond d'Alembert proposed such a derivation in 1743 which is quite clearly expressed, and therefore easily seen to be invalid[37]. Kant's argument is more difficult, because of his convoluted efforts to incorporate both empirical and necessary components into physical laws.

> Although Kant was as firmly persuaded as any empiricist that detailed knowledge of the physical world could be arrived at only by observation and experiment, he was also sure that physics has an unshakeable a priori basis that makes it worthy of the name of science. . . . The main object of the *Metaphysical Foundations* is to demonstrate the second of these points by means of an examination of the idea of matter.[38]

Kant's argument is in outline as follows. Corresponding to his three transcendental relational principles of substance, causality and community, in mechanics there are the three synthetic *a priori* principles of pure natural science, namely the conservation of mass, the law of inertia and the equality of action and reaction. Applying these principles to Kepler's (empirical) laws of planetary motion yields the universal law of gravitation (this is a similar derivation to Newton's described earlier, Section 4), which consequently is more than an inductive law, as it possesses both empirical and necessary components. Kant commented on the outcome of this process:

> It is . . . a remarkable appearance in the field of science that there was a moment where its progress appeared to be terminated, where the ship lay at anchor and there was nothing further to be done for philosophy in a certain field [Kant has transformed Newton into a petrified state]. *Kepler's* three analogies had enumerated the phenomena of orbital motion of the planets completely [this ignores the fact that Newton modified them], although still only empirically, and mathematically described them without yet providing an intimation of the *moving forces*, together with their law, which may be the cause thereof.
>
> Instead of Kepler's *aggregation* of motions containing empirically assembled rules [exhibiting mathematical truth only], Newton created a principle of the system of moving forces from active causes [exhibiting philosophical truth, formerly regarded as mathematical truth by Berkeley].[39]

Thus was mathematical truth rationally transformed into philosophical truth. It appears that the necessary component in Kant's derivation of the universal law of gravitation enters via the transcendental principles and their correspondence to the principles of natural science: in particular, the correspondence between causality and the law of inertia, which presumably means that

---

[37] See Ernest Nagel, *The Structure of Science*, p. 175

[38] W.H. Walsh, "Immanuel Kant", p. 321

[39] Immanuel Kant, *Opus postumum*, 22:521, p. 179

these are in some way equivalent. Concerning the law of inertia Kant writes:

> *Life* means the capacity of a *substance* to act on itself from an *inner principle*, . . . of a *material substance* to determine itself to motion or rest as alteration of its state. . . . all matter as such is *lifeless*. This, and nothing more, is what the proposition of inertia says.[40]

Thus if the law of inertia corresponds to lifelessness, then lifelessness must correspond to causation.

To explore this conclusion further, consider the first two statements of d'Alembert's argument (referred to above) which relate to the part of the law of inertia concerning a body at rest:

> A body at rest will remain so, as long as an external cause does not move it.
>
> For a body cannot be brought into motion by itself, since there is no reason why it should move in one direction rather than another.[41]

Suppose a body move from rest in a certain direction. How do we explain this change? If the body is animate and the movement is voluntary, we seek a reason by considering the state of its mind (Latin *animus*, mind). If the body is inanimate, say an alarm clock that dances around on the mantle shelf, we may ascribe the reason for its motion to itself. If the body is any piece of matter at all, there are two alternatives: (1) If there is no obvious external cause, such as impact with another body, we seek the reason for its motion within itself by, in a sense, ascribing animus to it. This alternative appears to be the earliest that occurs in human development, either in individual development from birth or in the development of culture, and is the only practical alternative where explanation of human action is required. Modern man may in certain circumstances display the same primitive tendencies when confronted with behaviour of complex phenomena of which he has but little understanding, such as a computer or the weather. This ascription of animus clearly has a descriptive function in explanation, in a similar way to myth, enabling patterns of change to be identified and committed to memory, but it has limited predictive capability in the physical world, as the failure of its advanced formalization in Aristotelian physics demonstrates. This failure brings us to the second way of explaining change. (2) Given that there are circumstances in which it is unprofitable to ascribe animus to matter, in order to achieve an ability to explain the movement of bodies composed of such matter, or to predict their future movement, it is natural to look for some causal explanation. The causal alternative has, of course, always been followed in man's manipulation of the material world in circumstances where he has been able to develop a precise knowledge of its behaviour, such as in the routine execu-

---

[40] Immanuel Kant, *Metaphysical Foundations of Natural Science*, 4:544, p. 182

[41] Jean le Rond D'Alembert, *Traité de Dynamique*, p. 175

tion of technique. The extension of this alternative beyond the practical into the theoretical arena marked the birth of modern science. First, Galileo made a detailed examination of what it was, in the gravitational fall of a body say, that needed to be explained. Second, Descartes devised hypotheses to explain motion in terms of the only known inanimate cause of motion, impact between bodies. These were shown by Newton to be false. Third, Newton constructed a theory of force which explained most of the large scale movements of inanimate matter known at the time. One exception was magnetism, which continued to be regarded as of an animate nature until it too was examined quantitatively and incorporated into the causal structure of physics.[42]

From this discussion it can be seen that there are two tacit assumptions underlying d'Alembert's statements. First, animus cannot be successfully ascribed to all matter for the purpose of explaining its spontaneous movement. This is clearly not self-evident: it is empirical, based on the failure of alternative (1) in the physical world. It took man thousands of years to escape from it, an escape which was impeded by its being embedded in an influential philosophical system. Second, there is the idea that one should seek a causal explanation in circumstances where one's concern is with matter as essentially lifeless. This also is not self-evident. Causation as a principle that may be profitably applied to the study of nature only came into full effect with the scientific revolution, as we have seen. In the way it functions causation represents a guiding principle for scientific practice, the seeking of explanation by means of quantitative, unified, causally inspired theory: causation thus has a heuristic function. But this principle is not only not self-evident, it is false at the level where quantum theory provides the appropriate description.

Where gods are irrational and the decisions of autocrats are unpredictable, the idea of cause as a principle of investigation of natural phenomena hardly arises. This offers a clue as to the conditions that are propitious for the development of modern science, one of the questions we observed earlier that Comte's Law does not answer. A.N. Whitehead makes the following proposal.

> I do not think, however, that I have even yet brought out the greatest contribution of medievalism to the formation of the scientific movement. I mean the inexpugnable belief that every detailed occurrence can be correlated with its antecedents in a perfectly definite manner, exemplifying general principles. Without this belief the incredible labours of scientists would be without hope. It is this instinctive conviction, vividly poised before the imagination, which is the motive power of research:—that there is a secret, a secret which can be unveiled. How has this conviction been so vividly implanted in the European mind?

---

[42] The first to make a thorough investigation of magnetism, William Gilbert in 1600, believed the magnet to have a soul. See E.J. Dijksterhuis, *op. cit.*, p. 395.

> When we compare this tone of thought in Europe with the attitude of other civilizations when left to themselves, there seems but one source for its origin. It must come from the medieval insistence on the rationality of God, conceived as with the personal energy of Jehovah and with the rationality of a Greek philosopher. Every detail was supervised and ordered: the search into nature could only result in the vindication of the faith in rationality. Remember that I am not talking of the explicit beliefs of a few individuals. What I mean is the impress on the European mind arising from the unquestioned faith of centuries. By this I mean the instinctive tone of thought and not a mere creed of words.
>
> In Asia, the conceptions of God were of a being who was either too arbitrary or too impersonal for such ideas to have much effect on instinctive habits of mind. Any definite occurrence might be due to the fiat of an irrational despot, or might issue from some impersonal, inscrutable origin of things. There was not the same confidence as in the intelligible rationality of a personal being. I am not arguing that the European trust in the scrutability of nature was logically justified even by its own theology. My only point is to understand how it arose. My explanation is that the faith in the possibility of science, generated antecedently to the development of modern scientific theory, is an unconscious derivative from medieval theology.[43]

What makes causation appear self-evident is that it is natural to us, immersed as we are in our post-Newtonian culture, to interpret our natural disposition to seek explanation as a disposition to look for causes, whereas explanation may at a more primitive level be sought by looking for reasons for action. It was as a post-Newtonian that Kant looked at the world and interpreted his own intuitions. However he was partly correct when he wrote: ". . . all matter as such is *lifeless*. This, and nothing more, is what the proposition of inertia says." A more precise conclusion from the above discussion is this: given that natural phenomena do not admit of scientific explanation on the assumption that matter is animate, the principle of causation may be adopted, applicable to both animate and inanimate matter, and from this follows the law of inertia in so far as it is concerned with matter at rest.

At the base of Kant's rationalization of physics do not lie necessary principles of space, time, causation and matter, but empirical propositions any or all of which may be false. What function does such a rationalization serve to carry out? From the point of view of the furthering of knowledge and understanding, the only function is to block it, at least as far as philosophy is concerned. Fortunately physics takes little notice, in its mature state, of philosophical claims of the necessity of empirical laws. Sambursky claims this to be true for all the exact sciences:

> When modern science turned its back on scholastic philosophy, and the philosophy of Aristotle, it simultaneously turned its back on all philosophy.

[43] A.N. Whitehead, *Science and the Modern World*, pp. 15-16

> Galileo and his pupils, the first members of the Royal Society in London, Newton, and Huyghens in Holland—all the founders of seventeenth-century science—were investigators of nature, not philosophers. After Descartes and Leibniz there were no philosophers who contributed anything of importance to the exact sciences. That was the parting of the ways. To-day the occasional contact between philosophers and scientists takes the form of an epistemological discussion confined to the meaning of the attainments of science and does not affect its methods.[44]

Shortly Kant's system was shown to be as useless in almost every one of its details as the philosophical systems that had preceded it—of space, time, causation, matter, and the physical principles derived from them. However, philosophical preconception continued to exert an obstructive influence on other emerging sciences, for example chemistry, discussed below.

The conclusion reached is that philosophy follows science rather than leads it, and that in doing this philosophy seeks to anchor science in place by a rationalization of its principles. This conclusion is based so far on the history of physics, which is fundamental to the other natural sciences and is thus of particular interest to philosophers. It is also a conclusion that assumes a clear distinction between philosophy and science, on the basis that science answers to observation while philosophy does not. This is not so much a contentious issue as one that requires elucidation. It will therefore be accepted for our present purposes and the elucidation postponed. Thus while philosophers may largely have been content with the state of physics at the end of the nineteenth century, in view of the fact that physics advanced from that state there were clearly physicists who were not content with it. Consider the example of Lord Kelvin, a leading physicist in the latter part of the nineteenth century. As recounted by David Bohm, he

> . . . expressed the opinion that the basic general outline of physical theories was pretty well settled, and that there remained only "two small clouds"[45] on the horizon, namely the negative results of the Michelson–Morley experiment [devised to test for the presence of the ether, which would act as the absolute frame of reference proposed by Newton] and the failure of [the] Rayleigh–Jeans law to predict the distribution of radiant energy in a black body.[46]

But as Kelvin's two clouds indicates, the saving grace of physics is that its concern is with that which is open to observational test, which is not the case with philosophy. For, Bohm continues,

---

[44] S. Sambursky, *The Physical World of the Greeks*, p. 224

[45] Kelvin writes in "Nineteenth century clouds over the dynamical theory of heat and light", 1901, p. 1, "The beauty and clearness of the dynamical theory, which asserts heat and light to be made of motion, is at present obscured by two clouds."

[46] David Bohm, *Causality and Chance in Modern Physics*, p. 68

> It must be admitted that Lord Kelvin knew how to choose his “clouds”, since these were precisely the two problems that eventually led to the revolutionary changes in the conceptual structure of physics that occurred in the twentieth century in connection with the theory of relativity and the quantum theory.

But there were also physicists (and other scientists) whose ideas tended to be held fixed by both philosophical and scientific preconceptions. To evaluate such cases the critical question that needs to be asked is, on what grounds were these preconceptions held, and on what grounds would they be given up? To function satisfactorily, science needs to incorporate a conservative stance, whereby certain non-philosophical preconceptions are left unexamined in its normal functioning—in what Kuhn calls ‘normal science’[47]. But science must also be open to questioning of such preconceptions when need arises by examination of their coherence and by empirical testing of theory incorporating both the preconceptions and alternatives to them. Where an individual scientist is not prepared to open his mind to such questioning, he is acting as philosopher rather than scientist, and may as a result be instrumental in impeding the progress of science.

The case of the physicist/philosopher Mach is of interest in this context. Mach was a positivist of phenomenalist persuasion. As a positivist he was led to a criticism of Newton’s assumption of the existence of absolute space and time, a criticism that acted as a stimulus for Einstein’s theory of relativity. We may count this as scientific criticism, as it could, and did, lead to testable theory. As a phenomenalist Mach opposed the reality of atoms to the end of his life in 1916, regarding them as entities devised merely for the purpose of organizing observational phenomena. One might ask on what grounds Mach, as a positivist, could distinguish between these two descriptions of the status of atoms, as real and as instrumental. What does the reality of a scientific entity consist in? If taken in its ordinary meaning, the phrase ‘the reality of a scientific entity’ is a convenient description whose use depends on the degree of integration of the entity into scientific theory and practice: thus atoms started to become real when their integration began to span both physics and chemistry. But if taken in some absolute, metaphysical sense, as Mach apparently took it, this phrase refers to a philosophical notion of reality whose use is not decidable on any empirical basis, and so from the positivist point of view is meaningless. In rejecting the reality of the atom when its integration into both physics and chemistry was progressing rapidly, Mach was acting as a philosopher.

The conclusion to be drawn from Mach is that a man may be a philoso-

---

[47] Thomas S. Kuhn, *The Structure of Scientific Revolutions*

pher in some context, a scientist in another, and this is no doubt true to some degree of any of us. There would therefore be no justification in pointing to some famous scientist and saying, "Here is a famous scientist availing himself of philosophical truth", and concluding that philosophical truth is necessary to creative science. (After all, there are famous scientists who believe in God.) What we must keep in mind is the process by which knowledge and understanding are achieved, not the individual actors in the process. This conclusion holds not only for actors, but also for ideas: an idea may be scientific in one context, philosophical in another. What decides this is whether the context is part of a scientific process or a philosophical process, whether the process is characterized by an endeavour to connect the idea to observation or not. This way of describing the scientific and the philosophical allows that an idea may move from one context to the other. Thus ideas of science may be taken up by philosophy and petrified, and ideas of philosophy may be taken up by science and given life. An interesting example of an idea moving from philosophy to science is atomism, which we shall now consider.

7. Atomism to 1800

Summary: *Atomism, introduced in the fifth century* B.C.*, appears to foreshadow and to be the stimulating idea for the modern concept of the atom. As it turned out, however, the modern concept was instigated and developed entirely within the empirical constraints of science.*

> In the history of science, as in other branches of history, it is necessary from time to time to indulge in revision, and to see whether the general picture we have inherited from the past is a satisfactory account of what actually happened, or is essentially myth. This is perhaps particularly so in the history of science, which has often been written in a whiggish manner as an account of the *progress* of science. Authors whose views seem an anticipation of modern theories are exalted, although usually the anticipation is far from complete, and the old and new theories were designed to explain different sets of phenomena. So it has been with atomism. Since, it is argued, the world is composed of atoms, those who in Antiquity or in modern times wrote in support of atomism were, in some strong sense, right; while those who opposed them were reactionary and wrong, or at least to be apologised for. This is absurdly unhistorical. If we are to assess scientists of the past, we must judge their views not by this kind of criterion but by their consistency and their power to explain the phenomena then known and felt to be puzzling. We shall then find that some atomic theories (for to some extent every atomic theory which explains new phenomena is a new and different theory) were sound and well based; while others were naïve and speculative.[48]

Atomism passed through a number of phases from its inception with Leucip-

[48] David Knight, *Atoms and Elements*, p. 1

pus and Democritus in fifth century B.C. Greece to its acceptance as part of mature science in the early twentieth century. While ‘atom’ has changed in meaning from phase to phase, there has nevertheless existed a continuity of meaning over phases for a period of two and a half thousand years. This is an extraordinary record for an idea that is almost entirely intellectual in origin, that states something concrete about the world, and yet has no direct connection with the observable. Two sciences with a similar record that come to mind for comparison with atomism are geometry and astronomy, but both of these were sustained by direct connection with the observable. The atomism of Democritus was part of the metaphysical argument of his time as to the form of what exists, and was devised primarily in answer to Parmenides’s argument, opposing the naturalistic philosophers, that change and the void are impossible: for Democritus, all change derives from the motion of unchanging atoms in a void. The very flexibility of this idea is its strength, for the only possibility it excludes is the infinite divisibility of matter, a notion that corresponds more to a mathematical idealization than a testable theory.

Reading through the history of atomism one can find foreshadowed many a modern idea about the atom. Brownian motion is a phenomenon whose quantitative explanation by Einstein is taken to mark the point when the reality of the atom became generally accepted. It is named after Robert Brown, who in 1827 drew the scientific community’s attention to the perpetual, random motion of pollen in water and other similar random motions, such as dust particles in air. Here is a description of the phenomenon:

> It is appropriate to examine with greater attention these corpuscles, the disorderly motion of which can be observed in rays of sunshine: such chaotic movements attest to the underlying motion of matter, hidden and imperceptible. You will indeed observe numerous such corpuscles, shaken by invisible collisions, change path, be pushed back, retrace their steps, now here, now there, in all directions. It is clear that this to-and-fro movement is wholly due to atoms. First, the atoms move by themselves, then the smallest of the composite bodies, which are, so to speak, still within reach of the forces of the atom, jostled by the invisible impulse from the latter, start their own movement; they themselves, in turn, shake slightly larger bodies. That is how, starting from atoms, movement spreads and reaches our senses, in such a way that it is imparted to these particles which we are able to discern in a ray of sunshine, without the collisions themselves which produce them being manifest to us.

Could this have been written by Brown? In fact it was written more than two thousand years earlier, by Epicurus[49], of which Bernard Pullman writes, “This passage is nothing short of an excellent introducion to the concept of

---

[49] Epicurus, p. 40

Brownian motion"[50]. And here is Newton speculating on atomic structure, for which there was no evidence in his time (the initial statement of this quotation was referred to earlier):

> Have not the small Particles of Bodies certain Powers, Virtues, or Forces, by which they act at a distance, not only upon the Rays of Light for reflecting, refracting, and inflecting them, but also upon one another for producing a great Part of the Phænomena of Nature? For it's well known, that Bodies act one upon another by the Attractions of Gravity, Magnetism, and Electricity; and these Instances shew the Tenor and Course of Nature, and make it not improbable but that there may be more attractive Powers than these. For Nature is very consonant and conformable to her self. . . . The Attractions of Gravity, Magnetism, and Electricity, reach to very sensible distances, and so have been observed by Vulgar eyes, and there may be others which reach to so small distances as hitherto escape Observation; and perhaps electrical Attraction may reach to such small distances, even without being excited by Friction. . . .
>
> Now the smallest Particles of Matter may cohere by the strongest Attractions, and compose bigger Particles of weaker Virtue; and many of these may cohere and compose bigger Particles whose Virtue is still weaker, and so on for divers Successions, until the Progression end in the biggest Particles on which the Operations in Chymistry, and the Colours of natural Bodies depend, and which by cohering compose Bodies of a sensible Magnitude.[51]

Given that neither Epicurus nor Newton knew anything of the modern physics that they appeared to foreshadow, it seems almost as if the true state of the atomic world could be discovered by thought alone. Putting this with a little more circumspection: plausible, qualitative and undetailed models for the structure of matter are fairly easily constructed. But we must remember that these are only models; the structure itself has not been easy to discover, and for the structure we have now, quantum mechanics, there is no single model expressible in terms of macroscopic phenomena. For science we need both models and structure with predictive capability, whereas philosophy deals only in models. The fact that the atomic model of Democritus has a rough resemblance to later scientific models does not make it scientific, or pre-scientific—it was metaphysical, because devised as a response within a metaphysical discourse. This metaphysical model, however, was the beginning of a series of atomistic models: passing from Democritus to Epicurus, Gassendi, and thence to Boyle and Newton. Can we say that at some point this series passed into a pre-scientific phase? Consider Boyle and Newton. At the time that these models were put forward the state of technique and scientific knowledge was such that it was not possible to relate atomistic assumptions to the observable world. Nevertheless their proposals, made by scientists on the

---

[50] Bernard Pullman, *The Atom in the History of Human Thought*, p. 41

[51] Isaac Newton, *Opticks*, Book 3, Query 31

basis of scientifically developed intuition, were more useful as speculative starting points for future scientific elaboration than rationally argued metaphysical proposals which are generally not as amenable to modification in the light of observational experience. Boyle's and Newton's atomisms could therefore be counted as belonging near the beginning of a scientific process. But how they are counted has little bearing on our concern with the relation between philosophy and science, because as it turned out the inauguration of atomism as a science was almost entirely generated from within science itself, owing practically nothing to philosophical or pre-scientific models. If philosophy had any influence on the development of scientific atomism, it was to impede it. But before considering the beginnings of scientific atomism in the early nineteenth century, we shall take a look at the development up to that time of chemistry, with which atomism came to be closely associated.

8. The Struggle to Make Chemistry Scientific, to 1800

Summary: *Turning chemistry into a science took most of the eighteenth century. Chemistry had first to extricate itself from the old philosophical four element theory of matter. This process was exacerbated by the phlogiston hypothesis acting in unison with the four element theory, and was finally completed by Lavoisier in the 1780's.*

It is convenient to regard the scientific development of chemistry, that is its development as a coherent theory backed by established experimental practice, as occurring in two stages. The first stage concerned the struggle to understand the nature of the components of a chemical reaction. It may be taken to have begun with the phlogiston hypothesis in the early eighteenth century and to have ended in the 1780's with Lavoisier's demolition of phlogiston, identification of common chemical reactants, including oxygen, and introduction of modern chemical nomenclature. Atomism played no active part in this stage. The second stage in the development of chemistry concerned the struggle to obtain precise formulae for chemical compounds and reactions in terms of chemical atoms, and in so doing to establish the concept of the chemical atom. This stage began in 1808 with the introduction of chemical atoms by John Dalton, and is usually taken to have ended in 1860 when Stanislao Cannizzaro gave a complete method for finding chemical formulae.

At the beginning of the eighteenth century chemistry was in possession of a wealth of observational data, much of it coming from alchemy, metal working and iatrochemistry, with a variety of explanatory myths associated with these practices, but no coherent theory by which to make sense of chemistry as such. For the classification of matter there had been no improvement on the ancient classification by Empedocles, deriving from earlier sources still, into the four elements of earth, water, air and fire, except where this was rejected, by Newton for example, in favour of some observationally unsubstantiated variant of atomism. There was also a persistent belief in the possession of animus by various substances, particularly the metals because of their resilient properties. The principal difficulties in the path of the development of chemistry on the theoretical side derived mainly from the four element theory and its subsequent formalization by Aristotle, from which it took chemistry until the mid-nineteenth century to fully extricate itself. These difficulties manifested themselves as follows.

Foremost was the difficulty of establishing the concept, fundamental to chemistry, of a material (or 'corporeal') substance. If earth and water are substances, then so, are air and fire. If fire is a substance, what then can it mean to be a substance? Does it mean only that it can produce a physical effect, or does it mean that it can be weighed? If the former, then if fire is a substance surely heat is also. Gassendi and Descartes, for example, thought that "heat, cold and magnetism were evidence of 'calorifick', 'frigorifick' and 'magnetick' corpuscles"[52]. Caloric was still current at the end of the eighteenth century, being included in both Lavoisier's and Dalton's lists of elements. On the other hand, if a substance is that which can be weighed, then it must be possible to weigh fire. Boyle believed he had weighed it:

> Since so many kinds of particles were ponderable, Boyle felt that 'calorifick and frigorifick' atoms might have a detectable weight also, and set about devising experiments to detect their presence with the balance. His experiments 'to make Fire and Flame Stable and Ponderable' eventually gave a positive result, and he concluded that he had actually *weighed* the sharp and piercing corpuscles of fire.
>
> His methods were exact and scrupulous. Eight ounces of tin were carefully weighed out and put into a glass flask, . . .[53]

What it was that made air a substance also faced a difficulty, for it was a long time before satisfactory means for weighing gases were developed. In fact, as air and fire were the two elements possessing levity, the idea that there could be gases quite distinct from air had a difficult conception, as for some time all gases were thought of as air containing various contaminants, called 'fumes'. The difficulty of weighing accurately also impeded the acceptance of weight as a decisive factor in chemical analysis, and this in turn facilitated the establishment of the phlogiston hypothesis. This derived from the ancient belief that combustion and the calcination of metals involved the giving up of something, phlogiston (from φλογ– flame), whose identity was uncertain, but was associated in some way with the material of fire produced in burning. For example, charcoal was said to contain phlogiston, which it gives up to calx

---

[52] Stephen Toulmin and June Goodfield, *The Architecture of Matter*, p. 203

[53] Toulmin and Goodfield, *op. cit.*, p. 204

(oxide of a metal) to produce metal, thus making all metals compounds. And as metals were regarded by alchemists as alive by virtue of their attractive and useful properties, phlogiston was thought of as the spirit that gave life to calx. When it was eventually found that phlogiston had negative weight, this phenomenon was identified with the Aristotelian notion of levity, in contrast with gravity, possessed by air and fire (and spirit), and further delayed the use of weight as a technique in chemistry. As the four element theory had water as an element, the discovery of the compound nature of water was impeded. At the same time this supported the phlogiston theory: for example, the discovery by Cavendish that combining hydrogen with oxygen produces water was interpreted by him as the combining of dephlogisticated water with phlogisticated water to produce the element water. Joseph Priesley is often credited with the discovery of oxygen (in 1774); but what he did was, in his own words, to isolate ‘dephlogisticated air’ (by that time air was recognized to be a mixture). The phlogiston hypothesis and the four element theory were mutually supporting.

One might have thought that, irrespective of the want of technical development, it would not have taken great insight or perseverance to have tried reversing much of this analysis, so that phlogiston becomes negative oxygen so to speak, water becomes a compound of hydrogen and oxygen, air becomes a mixture of oxygen, nitrogen and carbon dioxide, metals become elements, and everything falls into place. That is more or less what happened when Lavoisier set about his programme of experimentation and analysis of existing results in the 1770’s. But we can see why it took so long to reach this point. Insight of the order possessed by Newton in physics and Lavoisier in chemistry is possible only after technique has advanced sufficiently to establish unambiguous experimental results, and existing prejudices have been whittled away sufficiently by their confrontation with those results—no amount of rational argument alone is going to shake a philosophical prejudice. The most important technical development in chemistry was the balance and the corresponding incorporation of weight as a necessary criterion by which chemical analysis can be carried out, brought to prominence largely by Lavoisier. We cannot attribute the delayed chemical revolution to the phlogiston hypothesis, for this was only a device by which to preserve the philosophical ideas inherited from the ancient past and transmitted down to the eighteenth century by philosophers and artisans. We observe here another instance of philosophy impeding the development of science.

9. Scientific Atomism

Summary: Dalton proposed an atomic hypothesis to account solely for the proportions in which elements combine chemically, no physical properties of his atoms being required for this purpose. This pro-

posal was put forward in response to the chemical facts, owing virtually nothing to traditional atomic ideas. Many chemists were reluctant to commit themselves to this chemical atomism without further corroborating evidence. This reluctance was turned to outright rejection amongst a substantial body of chemists by the positivist movement, which rejected any hypothetical entity that could not be 'observed', and was consequently a negative influence on the development of atomism.

We have observed that while atomism had by 1800 been in existence as a hypothesis in one form or another for over two thousand years, it had never commanded, let alone received, any observational confirmation, it had never been more than a plausible hypothesis. The accepted form of atomism in 1800 was Newton's (see Section 7), which reflected qualitatively what was then known of physics and chemistry. Being without quantitative empirical support, it stood more as a point of reference for the atomic idea than as a programme of research.

John Dalton began his professional life in physics. His investigations in meteorology posed the question as to why atmospheric gases do not separate into layers according to their densities, and also resulted in his discovery of the law of partial pressures, whereby the pressure of a mixture of gases is the sum of the pressures that each alone would exert. This led him to consider an explanatory model in which gases consist of Newtonian type atoms of weight reflecting intrinsic gas density. This was only a qualitative model, which Dalton did not work out mathematically. It envisaged stationary atoms connected by springs and was therefore quite distinct from the models that were treated mathematically later in the nineteenth century in the kinetic theory of gases. Following the suggestion of his meteorological investigations, Dalton's attention turned to ". . . determining the *number* and *weight* of all chemical elementary principles which would enter into any sort of combination one with another"[54], particularly in view of Joseph-Louis Proust's recently discovered Law of Constant Proportion concerning chemical composition, whereby elements combine in any given chemical composition in fixed proportions by weight. For example, water is formed from one unit weight of hydrogen in combination with eight unit weights of oxygen. This points convincingly to an atomic structure. Further corroboration came from the several proportions in which elements may combine. For example, Proust had shown that tin and oxygen combine in either one of the two proportions 88.1% to 11.9% or 78.7% to 21.3%, depending on the chemical circumstances. Expressed in this form, there does not seem to be a suggestion of atomic combination. When Dalton

---

[54] John Dalton, *A New System of Chemical Philosophy*, as quoted in Toulmin and Goodfield, *The Architecture of Matter*, p. 231

expressed these proportions in the equivalent form 7.4:1 and 7.4:2, it could be seen (what cannot be seen in Proust's way of writing them) that the amounts of oxygen that combine with tin are in the simple proportion 1:2. Another example is the two compounds carbon monoxide, CO, and carbon dioxide, CO_2, whose proportions are 12:16 and 12:32. Similar examples led Dalton to his Law of Multiple Proportions: When the same weight of one element combines with different weights of another, the different weights are in simple proportions. On the basis of these two laws there is a very strong indication of an atomic structure (though not a proof), which Dalton proposed as his atomic hypothesis in his book of 1808, *A New System of Chemical Philosophy*:

> In all chemical investigations, it has justly been considered an important object to ascertain the relative *weights* of the simples which constitute a compound. But unfortunately the inquiry has terminated here; whereas from the relative weights in the mass, the relative weights of the ultimate particles or atoms of the bodies might have been inferred, from which their number and weight in various other compounds would appear, in order to assist and to guide future investigations, and to correct their results. Now it is one great object of this work, to show the importance and advantage of ascertaining *the relative weights of the ultimate particles, both of simple and compound bodies, the number of simple elementary particles which constitute one compound particle, and the number of less compound particles which enter into the formation of one more compound particle.*[55]

Thus Dalton proposed that elements occur in indivisible units called atoms, which combine chemically in simple multiples. No specific physical properties of these atoms needed to be assumed in order to give effect to their ability to combine chemically, though Dalton adhered to a physical model for which there was at that time no evidence. At this stage they were, in effect, only counting beads. In the case of two elements Dalton proposed that their atoms combine in one or more of the ratios 1:1, 1:2, 2:1, 1:3, 3:1, 2:3, etc., the earlier ratios being preferred on grounds of simplicity. Thus, as we now know, water is the combination of two hydrogen atoms of unit atomic weight with one oxygen atom of atomic weight 16, written $H_2^1O_1^{16}$, giving rise to a ratio by weight of 1:8, as observed. As, at the time, and at least until Cannizzaro (referred to in Section 8), there was no sure way of deciding the proportions in which atoms combine, Dalton incorrectly assumed, on the above grounds of simplicity, that the atoms of water occur in the ratio 1:1. It was because of this uncertainty that Dalton's concept of atom was not fully accepted by chemists for many years.

The beginning of scientific atomism has been recounted in a few of its details in order to demonstrate how a scientific hypothesis can be almost

---

[55] Dalton, *A New System of Chemical Philosophy*, p. 163

forced on the mind of the scientist by (1) the facts that confront him, and (2) the kinds of scientific model that are available to him. In the case of Newton a third influence could be added: (3) the mathematical (that is, structural) techniques that are to hand or that can be developed where required. (Remember that Newton developed the calculus in order to comprehend elliptical, orbital dynamics and gravitational attractive forces due to complex bodies. Dalton's atomic hypothesis involved only elementary mathematics.) The kind of scientific model available to Dalton was the atomism that had been part of man's culture since Leucippus and Democritus, and perhaps even before then and lost in the mists of time (as almost happened to Leucippus himself). Van Melsen comments on the philosophical sources of Dalton's atomic theory thus:

> Now that we have seen how Dalton's conception of the atomic theory was determined by the chemical science of his time, the question may be raised whether Dalton was also influenced by philosophic motives. As with so many other questions, this one may be answered both in the affirmative and in the negative. It all depends on the meaning of the question. The answer will be negative if the question is taken to mean whether Dalton deliberately chose a philosophic position, i.e. whether Dalton expressed his own opinion in the matter only after a previous examination of the philosophic foundations of the atomism proposed by Democritus, Empedocles, and Anaxagoras, or that proposed by Gassendi, Descartes, and Boyle, and of the minima theory proposed by Aristotle or Sennert. The answer will also be negative if the question is taken to mean whether Dalton, without mentioning or even knowing of the existence of previous viewpoints, nevertheless deliberately turned his attention to the problems of smallest particles which had caused disagreement among philosophers in former ages.[56]

He then goes on to consider how Dalton may have unconsciously taken over philosophical views of the past, such as the minima theory, which allowed the atoms of every element to be different from those of others, as Dalton did. It is not necessary to answer such questions, as the chemical data unambiguously point in that direction. Had atomism not existed, it is not hard to imagine its being invented by Dalton, or by some more brilliant mind of similar independent streak, as an obvious way of accounting for the chemical facts confronting him. In fact, the response of many chemists to Dalton's atomic proposal was that it was nothing more than that, a mere way of accounting for the facts of chemical composition. And at that time that was its sole, slender, but nevertheless compelling, connection with empirical observation, beyond which there could only be hope for a richer, deeper chemical theory in the manner of the unified theory that had been obtained for physics, one that would explain Dalton's seemingly arbitrary proliferation of atoms contrary to the accepted view of what an atomic theory should be like. This decidedly

---

[56] Andrew G. Van Melsen, *From Atomos to Atom*, p. 138

rational, if unsympathetic, assessment was the view of the majority of chemists. Representative of their views are those given by Humphry Davy on presenting, as President of the Royal Society, a Royal Medal to Dalton in 1826.

> [Dalton's] first views, from their boldness and peculiarity, met with but little attention; but they were discussed and supported by Drs Thomson and Wollaston; and the table of chemical equivalents of this last gentleman separates the practical part of the doctrine from the atomic or hypothetical part, and is worthy of the profound views and philosophical acumen and accuracy of the celebrated author. . . . With respect to the weight or quantity in which the different elementary substances entered into union to form compounds, there was scarcely any distinct or accurate data. Persons whose names had high authority differed considerably in their statements of results; and statical chemistry, as it was taught in 1799, was obscure, vague and indefinite, not meriting the name of a science. To Mr Dalton belongs the distinction of first unequivocally calling the attention of philosophers [that is, chemists] to this important subject . . . thus making the statics of chemistry depend upon simple questions in subtraction or multiplication, and enabling the student to deduce an immense number of facts from a few well-authenticated, accurate, experimental results.[57]

But there was another view in distinct opposition to Dalton's atomic hypothesis, which was based on more fundamental, philosophical grounds. This was the positivist view, two proponents of which we have met in the persons of Comte and Mach, and which was also represented amongst chemists by Wollaston, referred to by Davy. The positivist thesis was not just that there was insufficient data at the time on which to base an atomic hypothesis that was anything more than an accounting procedure; the positivist thesis was that there could never be any empirical basis for an atomic hypothesis, that atoms of the size required, smaller than the eye would ever be able to detect, could never be an object of knowledge, that therefore there could be no way of deciding, for example, in what proportions 'atoms' of hydrogen and oxygen combine to produce water. Comte wanted to restrict scientific knowledge to laws, that is, summaries of observable regularities. Mach wanted to go further than this, and restrict knowledge to the elements upon which he supposed observation to be based, what became known later as sense data. For these positivists, anything beyond the potentially observable can never be an object of scientific knowledge. In the case of Comte, this doctrine could lead to absurdity: for example, he asserted that it is nonsensical to speculate about the chemical constitution of an astronomical body, as it would be impossible to ever conduct the necessary chemical analysis to determine it—this was shortly before the development of spectroscopy enabled chemists to conduct the impossible analysis. Observation of the far side of the moon, another Comtean impossi-

---

[57] Humphry Davy, *Collected Works*, VII, p. 19

bility, had to wait longer. Up until about 1860 it was easy for a scientist to take a positivist attitude to atoms, which was a similar attitude to that taken to gravitational attraction before it became essential for the working scientist and was proclaimed on philosophical grounds to have an *a priori* basis. Many chemists adhered to the positivist view of atomism. One of these was Marcellin Berthelot, who had a great influence in France, as

> . . . he had a high-level government position, which gave him the power to interfere with the spread of ideas he disapproved of; his own official edicts practically banned the teaching of the atomic theory in favour of equivalent weights right until 1890. In fact Berthelot was an unbending equivalentist who limited the objective of science to devising classification schemes and recording relations between observable phenomena, in keeping with the purest positivist tradition (although he vigorously denied it). The atomic hypothesis was in his view only a "source of confusion" unworthy of being taught in chemistry courses.[58]

Berthelot wrote:

> Science must be based on laws [that is, empirical laws] and not on hypotheses. Laws can be proposed, debated, and definitively established, after which they become a solid foundation for science to progress steadily according to a methodology and language accepted by all. . . . Today, many chemists less attuned to the precision of physical notions pretend they can replace the strict definitions of the laws themselves with murky descriptions—hypotheses, that is, which change with each generation, each school of thought, or even each individual.[59]

But as the kinds of observation that were made sense of by an atomic hypothesis, at first purely chemical, then physical, grew in diversity and unity into a scientifically compelling case for atomism, positivism in its physical/chemical expression lost the interest of philosophers, who sought fresh fields in which to do battle in the newly emerging behavioural sciences. The influence of philosophy on scientific development had once again, in the case of atomism, been negative.

The reason for the failure of positivism was the same as the reason for the failure of all philosophical dogmas, its foundation on doctrinaire assumptions, based solely on prevailing intuition, cultural and religious affinity and philosophical prejudice, as to the limits of possibility: possible observation, possible theoretical construct, possible connection between the two. Every metaphysics is founded on such assumptions, but positivism was distinct in attempting to limit possibility in order to eliminate metaphysics, by restricting theoretical entities to those which could be observed 'directly'. It failed not only because this attempt involved a contradiction, being itself based on a

---

[58] Bernard Pullman, *The Atom in the History of Human Thought*, p. 233

[59] Marcellin Berthelot, Debate at Institute of France, p. 233

metaphysical precept, but also because the limitations it assumed were based on a misunderstanding of what constitutes observation, a concept which they never succeeded in making coherent, and consequently could not reach agreement on.

It is true that scientific theory also limits possibility: if it did not, it would not have content. But limits to possibility in science are not laid down dogmatically, but are hypothetical, being entailed by specific theoretical construction, and hence always open to refutation. For example, the impossibility of absolute space and time is not laid down as an inalienable physical principle, but is entailed by the positive proposals of the theory of relativity.[60]

10. Recapitulation

Summary: A graphical summary of the main influences between religion, philosophy and science is presented in Figure 1 at the end of Part I.

The historical evidence has been restricted thus far to the exact sciences, those amenable in their early development to mathematical treatment. This has been due to the author's greater familiarity with these sciences and the need to restrict the historical evidence under consideration. It should not be concluded, however, that the nature of the interaction between philosophy and science observed in the exact sciences is not also clearly evident in the biological and behavioural sciences. Thus, regarding the theory of evolution, by which biology has achieved a scientific unity both within itself and with other sciences, and which has also had an enormous effect outside biology, and on philosophy itself, we find that this was established through the enormous weight of observational evidence collected by Darwin, not in consequence of philosophical speculation, which on the whole acted as an impediment to its establishment. Consider, for example, the following quotation from Ernst Mayr, a biologist described as one of the main architects of the modern synthesis of genetic and evolutionary theory:

> Hindsight suggests that enough facts were available soon after 1859 to have permitted the universal acceptance of Darwin's theories, yet they were not universally adopted until about 80 years later. What could have been the reason for this long resistance? This is what historians have long asked themselves, but a satisfactory answer was not found until rather recently. The resistance, it was found, was due to the dominance of certain almost

---

[60] Einstein's equivalence principle is that "in a small region of space-time (*locally*) it is not possible operationally to distinguish between a frame 'at rest' in a uniform gravitational field and a frame being uniformly accelerated through empty space" (Cushing, *Philosophical Concepts in Physics*, p. 252; see also quotation from Einstein in Part II, Section 2 of this thesis). If some such statement of the principle be taken as a positive proposal of the general theory of relativity, then it is clear that absolute space and time is inconsistent with it, in the local sense of the principle.

> universally held philosophical ideas in the worldview of Darwin's opponents. A strict belief in the literal truth of every word in the Bible was one of them. Its power, however, was limited, as is shown by the rapid acceptance (except by creationists) of Darwin's theory of common descent. However, several other ideologies in conflict with Darwin's theories were essentialism and finalism. . . . It is quite impossible to understand the nature of post-Darwinian controversies unless one understands the nature of the ideologies opposed to Darwin.[61]

From the historical evidence considered the following conclusions can be drawn in respect of the pursuit of knowledge. Knowledge is obtained through the development of technique in manipulating things, including the establishment of empirical laws, and through ensuing theoretical constructs of science. There is no single inspirational source for scientific theory. While a science is in its infancy and has little theoretical content, theory is suggested by analogy with theory from other sciences, and by models based on familiar phenomena conforming to known empirical laws. Philosophy scarcely enters into it. The problem with philosophical models is that they are not designed to satisfy an overriding empirical requirement, but to satisfy philosophical agenda irrelevant to and often inimical to science. When a science is mature, theory is created from within science, or stimulated by new empirical results, or by developed scientific intuition, or by theoretical developments in other sciences, or by progress toward unification with other sciences. Philosophy and science appear to be more closely associated than in fact they are because they both prosper in similar social contexts and because they are both concerned with explanation. No doubt there is some mutual stimulation of each by the other's example of free speculative activity. But as to particular developments, the relationship is asymmetrical: philosophy often inhibits scientific development, while scientific development stimulates philosophy to adopt new positions from which it may attempt to further inhibit scientific development. (No wonder Feynman refers to philosophy as a disease (see Section 3).) The asymmetry is easily understood. Science develops in response to technical and empirical development, which in turn arise in the context of political, economic and cultural circumstances (including warfare). In turn, science stimulates the developments to which it responds, and influences its circumstances. Comte seems to be right in saying that philosophy developed from religion, adhering to the non-empirical, metaphysical nature of its progenitor. An examination of the Greeks bears this out (discussed in the next section). Just as religion seeks intellectual and political control, so does philosophy, which therefore seeks to control scientific development, or failing this, to control its interpretation. It is clearly not the business of philosophy to seek

---

[61] Ernst Mayr, *What Evolution Is*, pp. 79-80

knowledge, and being non-empirical, it is not possible for it to do so. All it can do is apply a rational gloss over common experience, including the offerings of science as they appear.

11. Explanation, Technique and the Greeks

Summary: *The use of explanatory models incorporating familiar concepts is common to religion, philosophy and science. Only religious explanation existed until 600* B.C., *when conditions in Greece and its colonies were congenial to the rise of the Pre-Socratic philosophers. Those conditions were primarily freedom from monarchical and priestly dominance and the stimulus provided by cultural variety. Characteristic of the first philosophy was both its naturalistic content, which was adapted to some extent from existing mythology, and its speculative freedom. Apart from atomism, later Greek philosophy became unduly influenced by axiological considerations. Coexistent with religious and philosophical explanation was technique and craft, for which Aristotle used the terms episteme for the former, techne for the latter.*

The existence of experimental science requires active interaction between episteme and techne, which for the Greeks was almost non-existent, so that the Greeks cannot be said to have been engaged in science, but only in those two separate activities. The failure to engage in science proper was due to the dominating influence of episteme, as represented by Plato and Aristotle, which blocked the creation of science from within techne itself, the basis upon which science was finally created in the seventeenth century. This dominant episteme had originated in response to the incipient science of the Pre-Socratics. Without a scientific basis, techne gradually declined; and without a scientific inspirational source, Greek philosophy also declined, relapsing into the dogma from which it first arose.

It was observed in Section 10 that philosophy and science are both concerned with explanation. As observed in Section 6, man has a natural disposition to seek explanation; and because religion too is concerned with explanation, and provides it in the most elemental form, there is a universal presence of religion and myth in primitive societies. Man has always found himself confronted by apparently unanswerable questions concerning his existence in this world, and concerning the world itself. Consider, for example, the following question: “How can it be that in a world that has apparently existed for countless ages, and no doubt will continue to exist for countless ages, I will at my death have existed for only a brief moment of those countless ages? Why do I exist at just this particular time rather than at some other time? Why, indeed, is my life not coexistent with the world of which I feel so much a part? As it is not, then how is it possible that I can come into possession of knowledge of the world? Is it not, rather, that I can never gain knowledge of the world as it really is, that I am like a prisoner in Plato’s parable of the cave, where what I see is but a shadow and the sounds I hear but echoes of the real world lying beyond my apprehension." Or consider the unanswerable grief that is experienced on first learning that a loved one will never again respond to one's voice or to the touch of one's hand—what comfort can one then find but in conjuring into existence a world beyond that of our immediate experience where the loved one may dwell? There is thus the mystery of the world that exists independently of our perceiving it, the world that we can never come to know immediately—without the mediation of our own selves—but imagine that somehow we can be sure exists as the foundation of all our knowledge and of our very existence. This is the world of the gods of religion, or in philosophy it is the reality behind the appearance—at least for the realist of a metaphysical persuasion. But in the practice of science the only world is that which comes to knowledge by means of its own endeavours, as an object of its own theorizing.

Until the advent in about 600 B.C. of the first Greek philosophers, the Pre-Socratics, the only way of coming to terms with such apparently unanswerable questions was through the offerings of established religion, as it has continued to be for the great majority of mankind. Religion usually answers such questions as the ones asked above with some notion of the eternal and the supernatural. Thus with the Christian religion there is life everlasting, a loving God who watches over us and is the source of all things, and so on. This is of the nature of an explanation, which in its primitive form amounts to the construction of a teleological model based on familiar circumstances analogous to the circumstance requiring explanation. The Christian model explains life and death using the ideas of life everlasting, God the Father and so on, by analogy with the familiar circumstances of our lives. It is through its invented components that the explanation obtains its ability to explain: the phenomenon to be explained is projected, so to speak, into the explanatory model, by which it may be comprehended. Such processes of explanation are also used in philosophy and science, and enable a measure of unification and grounding to be achieved for our understanding: unity is attained by means of invented entities which participate in a variety of explanations, God for example, or the atom, while grounding derives from reference to circumstances that, because of their familiarity, are felt not to be in need of explanation. Standing alone, such explanation does not provide any predictive capability beyond that suggested by the familiar processes to which it alludes. It may be no more predictive than a fairy tale, and is similar to a fairy tale in its ability to allay fear and uncertainty: as a fairy tale is used by the authority figure of the parent to soothe or control the child, so the religious tale is used by the priest to placate or control the believer.

With the Pre-Socratics there was an advance in the manner of coming to terms with problems of the world and man's existence in it: explanation was freed from its dependence on myth handed down by religious authority and opened to free, individual speculation. This is generally taken to be the beginning of Western philosophy. Important contributory causes of this development were no doubt the variety of cultures and religions that Greece was exposed to by virtue of its maritime trade and the absence of a priesthood, the effect of which was to produce scepticism of explanations emanating from authority, an economic and political order that supported the leisure for free enquiry and is tolerant of the free development of ideas, and a culture that valued individual creativity. Religious tolerance is part of both the political and the cultural conditions, and it was the religious tolerance, or at least the freedom from priestly dominance, in both early Greece and post-Reformation northern Europe, that allowed a spirit of free enquiry to prosper. These conditions are not sufficient, however. Also required is cultural stimulus of the kind that derives from interaction and competition between cultures, which was vigorous in both Greece and Europe, and, together with the first conditions, would appear to have been sufficient for the development of a state of vigorous philosophical enquiry; sufficient, that is, given a requisite complexity and maturity of cultural development, for we must remember that Rome never produced original philosophy or science.

It must not be assumed, however, according to Burnet,

> that the Greeks of historical times who first tried to understand the world were . . . in the position of men setting out on a hitherto untrodden path. The remains of Aegean art prove that there must have been a tolerably consistent view of the world in existence already, though we cannot hope to recover it in detail till the records are deciphered. . . .
>
> On the other hand, it is clear that the northern invaders [the Achaians] must have assisted the free development of the Greek genius by breaking up the powerful monarchies of earlier days and, above all, by checking the growth of a superstition like that which ultimately stifled Egypt and Babylon. . . . It was probably due to the Achaians that the Greeks never had a priestly class, and that may well have had something to do with the rise of free science among them.[62]

The unification of understanding provided by the supernatural entities of religion was replaced by general metaphysical principles of a naturalistic kind, such as the principle that all natural phenomena derive from a single substance. For Thales, the first Pre-Socratic, that substance was water, a belief that no doubt ultimately derived from outside Greece:

> There are strong similarities between some of the Greek cosmological stories and the theogonical myths of the great river-civilizations and their neighbours; these similarities help to explain some details of Greek accounts

[62] John Burnet, *Early Greek Philosophy*, pp. 3-4

> down to and including Thales.[63]

The naturalism of the Pre-Socratic philosophers is attested by Aristotle:

> Most of the first philosophers thought that principles in the form of matter were the only principles of all things; for the original source of all existing things, that from which a thing first comes-into-being and into which it is finally destroyed, the substance persisting but changing in its qualities, this they declare is the element and first principle of existing things, and for this reason they consider that there is no absolute coming-to-be or passing away, on the ground that such a nature is always preserved . . . for there must be some natural substance, either one or more than one, from which the other things come-into-being, while it is preserved.[64]

For the Greeks there was a tendency to subject explanation to an overriding axiological constraint, a tendency which only increased with time.

> This tendency towards axiological distinctions, the consequences of which were very important for science—a tendency which was carried to such extremes that one is inclined to speak of axiologism—as a rule appeared to be determined more by aesthetical and teleological points of view; one thing was valued above the other because it was more beautiful or better suited to the purpose. With this was combined the optimistic view that Nature always strives to adapt itself to these human considerations. In a great many variants it was stated that Nature always tries to do what is good and profitable for man, endeavours to realize the best of what is possible, does nothing unreasonable, never proceeds vainly or aimlessly, and always succeeds in attaining maximum achievement by minimum effort. What was to be considered beautiful in this connexion was chiefly judged by arithmetical or geometrical standards: the numbers 3, 5, and 10 were to be preferred to others, and a geometrical form ranked higher as it approached nearer to regularity.[65]

There is no doubt that where explanation is not also subject to an effective empirical constraint, an axiological tendency can become an impediment to understanding and to the readiness to face the facts. This was certainly the case for Greek philosophy, with the sole exception of atomism. On the other hand, where an effective empirical constraint operates, as in modern science, an axiological influence in explanatory models can be of some heuristic value. Let us now consider the empirical side of the Greek experience.

Coexistent with religion and philosophy occurred the practical development of technique or craft, whereby prediction and control of nature are sought. This included astronomy, metallurgy, chemistry, medicine, animal husbandry, agriculture and mensuration. Craft does not concern itself with

---

[63] Kirk, Raven and Schofield, *The Presocratic Philosophers*, p. 7. See also p. 92 for comment on the origin of Thales's cosmology.

[64] Aristotle, *Metaphysics*, A3, 983b6

[65] E.J. Dijksterhuis, *op. cit.*, p. 76

general theoretical principles or with the explanations of religion or philosophy, but rather with an assemblage of practically effective procedures, which are developed for direct service in support of daily needs and cultural cohesion. Thus the Babylonians had an extensive record of astronomical observation from which they were able to predict lunar and solar eclipses with some accuracy without knowing anything about the solar system and without reference to cosmological myth; the Egyptians had a system of mensuration for the purpose of surveying land periodically inundated by the Nile without developing a mathematical basis for it. Here it is useful to introduce the terms *techne* and *episteme*, in the sense used by Aristotle:

> Aristotle had nothing against practical knowledge, which he called *techne*; he simply did not consider it to be the same kind of thing as scientific knowledge, which he called *episteme*. . . . For Aristotle . . . the difference between *techne* and *episteme* was not a difference between application and theory, but was one of sources of knowledge and goals of knowledge. The source of technical knowledge was practical experience and its goal was, roughly speaking, knowing what to do next time. The source of scientific knowledge was reason, and its goal was the understanding of things through their causes.[66]

We might say that these two activities are attempts to answer two different kinds of questions: in the case of *episteme*, 'why' questions seeking reasons and explanations, which by the nature of explanation are often subject to axiological influence; in the case of *techne*, 'how' questions concerning processes, which may be termed instrumental.

For the Babylonians and the Egyptians *techne* and *episteme* did not draw on each other to any significant extent for their development, but remained separate activities carried out at different levels of the class structure, *episteme* by the ruling and religious classes, *techne* within the lower ranks of society. An important influence on the emergence of the Pre-Socratics was an opening up of the ruling class in Ionia, where they originated, to merchants and traders, thus allowing *episteme* to make some connection with *techne*.

> In Ionia, on the Aegean fringe of the Anatolian mainland, conditions in the sixth century were very different [from the ancient empires of the Near East]. Political power was in the hands of a mercantile aristocracy and this mercantile aristocracy was actively engaged in promoting the rapid development of techniques on which their prosperity depended. The institution of slavery had not yet developed to a point at which the ruling class regarded techniques with contempt. Wisdom was still practical and fruitful. Miletus, where Natural Philosophy was born, was the most go-ahead town in the Greek world.[67]

---

[66] Stillman Drake, *Galileo*, p. 11

[67] Benjamin Farrington, *Greek Science*, p. 35

Because of the association between *techne* and *episteme* in Ionia, the Pre-Socratics could also be described as the forerunners of Western science. However, although they are often referred to as scientists, this description is hardly justified by the facts (at least not if we adhere to the modern meaning of science), for the *techne–episteme* connection involved no essential element of scientific experimentation, that is, active interaction between *episteme* and *techne* for the benefit of technique and for the empirical testing of theoretical hypothesis.

> Systematic experimentation in the laboratory was first carried out in the seventeenth century. It was, to all intents and purposes, unknown to the Greeks. Thus the riddle of the backwardness of terrestrial physics in comparison with astronomy in antiquity resolves itself into the problem of why there was almost no use of the laboratory experiment in Greek science. . . . The very idea of such an experiment, the way in which it is conducted, the apparatus set up for it and the processes revealed in the course of it are all the result of theoretical considerations. In carrying out this purely intellectual scheme the scientist produces a phenomenon which sometimes has no parallel in any natural process and the sole purpose of which is to confirm the given scientific theory. So we see that experiments of this kind are not intended to show how nature does function, but how it could function if the scientific conjecture prove to be correct. Here we have an extrapolation from actual to potential phenomena. The latter become actual only in the laboratory. In such a sense we may call an experiment unnatural. This, no doubt, is how it seemed to the Greeks, who would have thought it paradoxical to study natural phenomena by unnatural methods.[68]
>
> Thus in antiquity the two types of scientific activity did not merge into a single stream as they have gradually done in modern times, since Galileo and Newton. . . .
>
> In view of these serious shortcomings it is astonishing to what an extent arbitrariness was reduced by the extraordinary flair of the Greek mind for rational speculation in the right direction.[69]

With the change from Pre-Socratic to Socratic philosophy such mutual *techne–episteme* influence as had been established entered a long period of decline. How can this be accounted for? Farrington describes the social and philosophical influences making for this decline as follows.

> In the earlier period of Greek thought, then, when the sciences were not distinguished from the techniques, science was plainly a way of *doing* something. With Plato it became a way of *knowing*, which, in the absence of any practical test, meant only talking consistently. This new kind of 'science', like its predecessor the technical mode of explanation, resulted from a change in the character of society. Historians of society are still disputing the precise degree to which the industrial techniques had, by Plato's time, passed into

---

[68] S. Sambursky, *The Physical World of the Greeks*, pp. 233-235

[69] S. Sambursky, *The Physical World of Late Antiquity*, pp. ix, x

> the hands of slaves. For our purpose it is not necessary to give a more precise answer to this question than to say that for Plato, and for Aristotle, the normal and desirable thing was that the citizen should be exempted from the burden of manual work and even from direct control of the workers. The kind of science they aimed at creating was a science for citizens who would not directly engage in the operational control of the physical environment. Their modes of explanation necessarily excluded ideas derived from the techniques. Their science consisted in being able to give the right answers to any questions that might be asked. The rightness of the answer mainly depended on its logical consistency.[70]

Farrington goes on to note that the emphasis on logical consistency "was not all loss", as the application of mathematics and logic proceeding from it sharpened the analyses issuing from the Pre-Socratic period.

One might be tempted to attribute the failure of the Greeks to establish a viable science to the failure of *episteme*, of Greek philosophy, to interact with *techne*, with the empirical. This failure was certainly not for want of technical achievement, which was phenomenal in mathematics, astronomy, mechanics, biology and medicine. However we have seen from consideration of modern cases of scientific development that it is not from philosophy that science should expect inspiration, but from within its own ranks, from the experimenters themselves, from men such as Galileo and Newton. So we should be asking, why did a viable science not develop from *techne*? Here again we can look to the modern scientific experience for an answer. In modern times religion and philosophy have often attempted to block scientific progress; in Greek times there was insufficient "critical mass" on the technical side from which to generate a scientific *episteme*, or explanatory framework, from within the technical ranks that could act independently of, and where necessary oppose, the dominant philosophical *episteme* that had been laid down by Plato and Artistotle.

> In ancient Greece the scope of experimental research remained restricted because the Greeks, with very few exceptions, failed to take the decisive step from observation to systematic experimentation. Thus hardly any links were formed between the few branches of science [that is, *techne*] which developed, and they did not expand sufficiently to produce a coherent and interdependent system. The body of scientific knowledge in antiquity did not reach the critical mass necessary to induce the great scientists themselves to make an attempt at the construction of a theoretical framework which would unite the results of their own research and that of other branches of science.[71]

Let us consider what it was that the dominant philosophy of Plato and Aristotle arose in response to. Burnet believes that

---

[70] Farrington, *op. cit.*, p. 141

[71] S. Sambursky, *The Physical World of Late Antiquity*, p. x

> From the Platonic point of view, there can be no philosophy where there is no rational science. It is true that not much is required—a few propositions of elementary geometry will do to begin with—but rational science of some sort there must be. Now rational science is the creation of the Greeks, and we know when it began. We do not count as philosophy anything anterior to that.[72]

That is to say, the technical and mathematical achievements of the Pre-Socratics, together with their speculative endeavours, constituted a challenge to philosophical analysis that was a crucial influence in bringing the philosophy of Plato and Aristotle into existence in the form it assumed, and by its axiological orientation and lack of interest in empirical results as such (Aristotle's biology notwithstanding), blocked the transformation of *techne* from a technological achievement into a scientific enterprise.

But technology can progress only so far without a scientific base, and so after about 200 B.C. it gradually declined. Farrington puts this in a social context:

> Science had ceased to be, or had failed to become, a real force in the life of society. Instead there had arisen a conception of science as a cycle of liberal studies for a privileged minority. Science had become a relaxation, an adornment, a subject of contemplation. It had ceased to be a means of transforming the conditions of life.[73]

And without science as a liberator of thought, philosophy itself declined, reverting back into dogma, from which it had once freed itself.

> In the ancient world the mass of the population never attained, either in the East or the West, to a scientific and rationalistic way of thinking. Even in the educated section of Graeco-Roman society such a habit of mind was rare; and religion still governed their general view of life. I have explained already how philosophy, especially Stoicism, adapts itself to religion. From this connexion new doctrines arose, such as neo-Pythagoreanism, with its mysticism and predominant interest in a future life. By degrees these doctrines and even rationalistic Epicureanism were converted into systems, with every detail scrupulously worked out and accepted by its followers as absolutely true. Philosophical inquiry tended more and more to become what we call 'dogma'. Moreover, both Stoicism and neo-Pythagoreanism gave a distinctly religious form to their dogmas, and reduced philosophy to a system decidedly more religious than philosophical. Dogma by degrees became theology.[74]

12. Philosophical Problems and Problems with Philosophy

Summary: The nature of reality lies in the province of science. So also does the question of man's relation to reality. If there is a prob-

---

[72] John Burnet, *Greek philosophy*, p. 4

[73] Farrington, *op. cit.*, p. 302

[74] M. Rostovtzeff, *A History of the Ancient World*, Vol. II, *Rome*, p. 198

> *lem in the development of knowledge and understanding, it is to free it of unproductive philosophical speculation.*

If philosophy is dependent on science, then how is it possible that there could be a field of knowledge not answerable to the procedures of science which is accessible only through philosophical endeavour? This is what the Greeks believed:

> If we look at Greek philosophy as a whole, we shall see that it is dominated from beginning to end by the problem of reality. In the last resort the question is always, "What is real?" Thales asked it no less than Plato or Aristotle; and, no matter what the answer given may be, where that question is asked, there we have philosophy. It is no part of the historian's task to decide whether it is a question that can be answered, but there is one comment he may fairly make. It is that the rise and progress of the special sciences depended, so far as we can see, on its being asked. We find that every serious attempt to grapple with the ultimate problem of reality brings with it a great advance in positive science, and that this has always ceased to flourish when interest in that problem was weak. That happened more than once in the history of Greek philosophy, when the subordinate problems of knowledge and conduct came to occupy the first place, though at the same time it was just the raising of these problems that did most to transform the problem of reality itself.[75]

Burnet regards the problem of the nature of reality as an essentially philosophical problem, because while it acts as a stimulus to scientific advance,

> The problem of reality, in fact, involves the problem of man's relation to it, which at once takes us beyond pure science. We have to ask whether the mind of man can have any contact with reality at all, and, if it can, what difference this will make to his life.[76]

If the mind can have no contact with reality, then the question, 'can the mind of man have contact with reality?', which refers to reality, can have no meaning, cannot be comprehended by the mind. Therefore, if the question is to have meaning, it can only be answered affirmatively, in which case it is no question at all, let alone a philosophical question. This conclusion is consistent with the idea that to be able to function, to be able to think, we cannot do without some concept of a reality with which we can make contact, just as we cannot do without the law of the excluded middle—these are not presuppositions we make, but are bound up in the very notion of functioning and thinking. Given, then, that the mind *can* have contact with reality, what is the nature of that reality, and how is the contact made? Burnet appears to accept that the nature of reality is a scientific problem—Newton is characteristically clear about this: for example,

---

[75] John Burnet, *Greek Philosophy*, p. 11

[76] Burnet, *op. cit.*, p. 12

> There are therefore Agents in Nature able to make the Particles of Bodies stick together by very strong Attractions. *And it is the Business of experimental Philosophy to find them out*.[77]

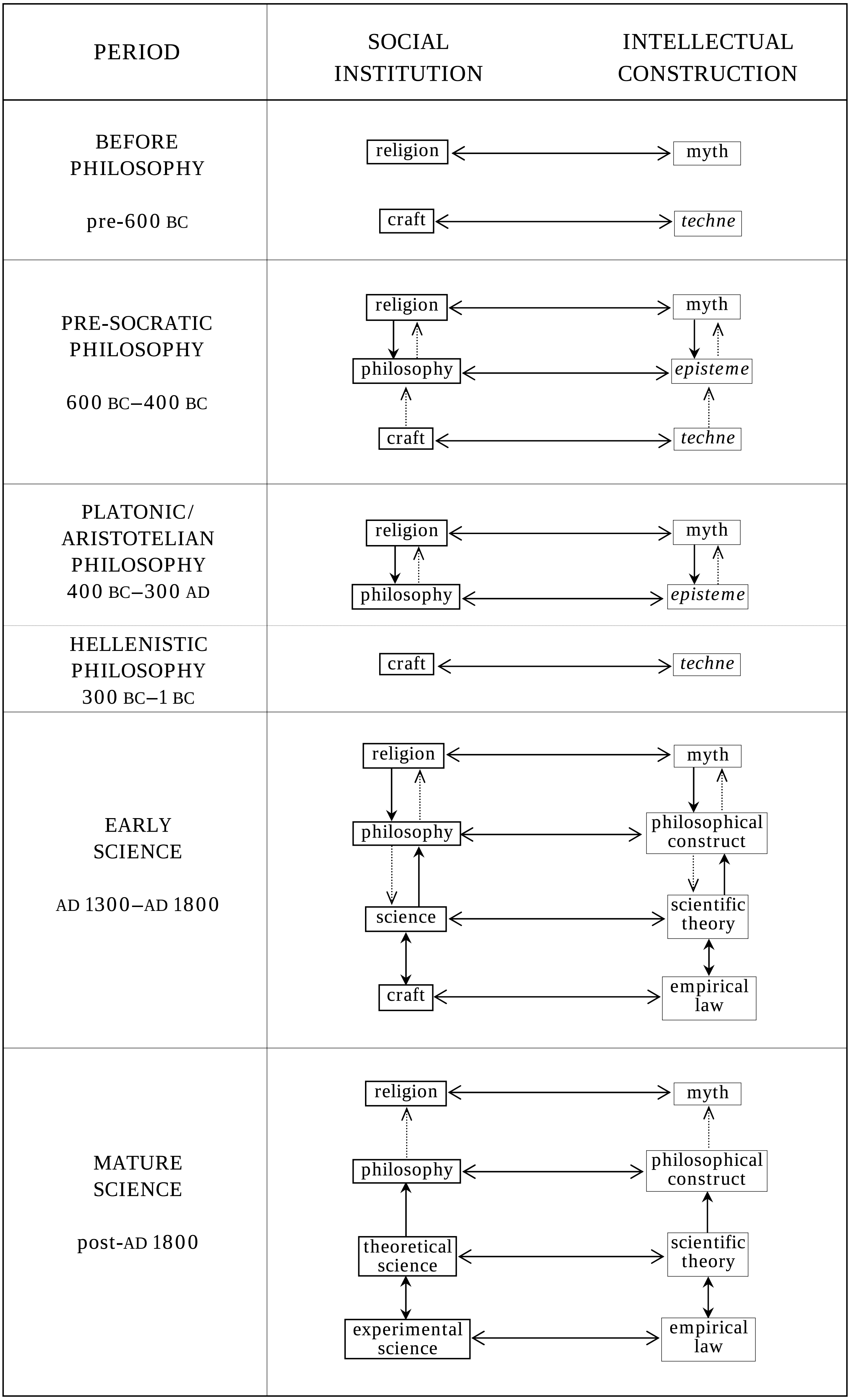
However, Burnet believes that the question of man's relation to reality, the question as to how the mind makes contact with reality, is not addressable by science. On the contrary, it is proposed here, and will be argued in Part II, that this last question can be given a clear meaning, and progress can be made in answering it, only in a scientific context; that science is now in a position to address the problem of man's relation to reality, as it may not have been when Burnet wrote (1914). The history of science and philosophy lends support to this.

If this thesis is true, then there are no inherently philosophical problems in the development of knowledge and understanding. But there have been problems arising from the involvement of philosophy in that development, for philosophy has not been a benign influence. This is not to lay blame on philosophy, but to recognize the significance of the historical facts, in so far as they can be epitomized by so brief an historical selection as that given here, and thereby to anticipate philosophical influence in the further development of knowledge and understanding.

---

[77] Isaac Newton, *Opticks*, Book 3, Query 31. Emphasis added.

FIGURE 1: THE EVOLUTION OF PHILOSOPHY IN RELATION TO RELIGION AND SCIENCE



PART II: Are There Essentially Philosophical Problems?

1. Introduction

Summary: *A description is attempted in Part II of the facts concerning the connection of philosophy and science with human experience.*

In Part I we looked at the historical relation between philosophy and science. Now we examine these disciplines in their relation to human experience, individual and cultural. The aim is factual description free of philosophical speculation and commitment. Given the subject matter, this is difficult, as so many terms useful for factual description in this area have philosophical connotations. For example, 'real' is a useful term when used in contrast to 'imagined', but can be confused with the term as used in discussions of philosophical realism. 'Representation' is also useful, but its use may suggest a commitment to the philosophical representation theory of perception. Care therefore needs to be taken to ensure that the factual reference of general terms is clear. With scientific description this is assisted by the requirement of an experimental basis: observational basis is not sufficient, unless one is clear about observational procedures.

The factual description of this part is intended as a means toward the resolution of philosophical puzzles. The thesis maintained is that there is no philosophical problem that cannot be resolved by dispelling the preconceptions on which it is based and treating the residue scientifically. The only problem is to show this.

2. Science and Everyday Thinking

Summary: *In science theory builds upon theory, with today's theory becoming tomorrow's observation. Analogous processes of building are seen in the evolution of the brain and in the development of science from sense experience via everyday thinking. Einstein regarded science as a systematic reconstruction of everyday thinking from its basis in sense experience. Once developed, the structures of science, the brain and everyday thinking operate seamlessly.*

In Part I we saw how the development of technique may, in propitious circumstances, give rise to a technically inspired imaginative capability that transforms it into science. As part of science, technique then becomes the observational /experimental aspect, while the imaginative aspect is identified with theory. The accretion of theory is a continuing process: as old theory is discarded or elaborated and modified into new theory, and yesterday's established theory becomes part of today's technical aid to observation (the philosophy of science's auxiliary hypothesis), a system of interconnected theoretical layers is built up, like new cities built over old, establishing their foundations amongst those below it. There is an analogous process by which the brain has evolved, from primitive old brain concerned largely with the olfactory sense, emotion and locomotion, to the neocortex of the higher animals, concerned with what can be more clearly identified as representation, which corresponds to the process by which the empirical laws of technique become overlaid by representational, theoretical constructs. This may be more than an analogy, for the development of science can profitably be viewed as an extension of the evolutionary development of the brain to the cultural/social domain; that is to say, the organizational structure that enables understanding of the world has been extended beyond the cerebral to the social; or expressed otherwise, it is a progression from sense experience to science via "everyday thinking".

Einstein wrote of science as follows:

> The whole of science is nothing more than a refinement of everyday thinking. It is for this reason that the critical thinking of the physicist cannot possibly be restricted to the examination of the concepts of his own specific field. He cannot proceed without considering critically a much more difficult problem, the problem of analyzing the nature of everyday thinking.[78]

The refinement in everyday thinking that Einstein had in mind for physics was a sort of reconstruction of everyday thinking from its basis in sense experience, for he continued:

> On the stage of our subconscious mind appear in colourful succession sense experiences, memory pictures of them, representations and feelings. In contrast to psychology, physics treats directly only of sense experiences and of the 'understanding' of their connections. But even the concept of the 'real external world' of everyday thinking rests exclusively on sense impressions.
>
> Now we must first remark that the differentiation between sense impressions and representations is not possible; or, at least it is not possible with absolute certainty. With the discussion of this problem, which affects also the notion of reality, we will not concern ourselves but we shall take the existence of sense experiences as given, that is to say as psychic experiences of special kind.[79]

That "physics treats directly only of sense experiences and of the 'understanding' of their connections" looks like a tenet of Ernst Mach's phenomenalism (though Einstein wrote in 1936). Whether or not it is meant in that way depends on what is to be understood by 'sense experience', and on whether the 'connections' of sense experience are meant to include everyday observation. Einstein acknowledges this ambiguity of meaning when he writes that "differ-

---

[78] Albert Einstein, "Physics and Reality", p. 59

[79] Einstein, *op. cit.*, p. 60

entiation [with absolute certainty] between sense impressions and representations is not possible”, implying that there may be a representational element in sense experience. Nevertheless, we see expressed here an idea of Einstein’s that probably derived from the influence of Mach, for some of the mental explorations leading to his two theories of relativity can be seen as reconstructions of everyday thinking. For example, Einstein wrote of “the happiest thought of my life”:

> When, in 1907, I was working on a comprehensive paper on the special theory of relativity . . . I had also to attempt to modify the Newtonian theory of gravitation in such a way that its laws would fit in the [special relativity] theory. Attempts in this direction did show that this could be done, but did not satisfy me because they were based on physically unfounded hypotheses. Then there occurred to me the ‘glücklichste Gedanke meines Lebens’, the happiest thought of my life, in the following form. The gravitational field has only a relative existence . . . *Because for an observer falling freely from the roof of a house there exists*—at least in his immediate surroundings—*no gravitational field.* Indeed, if the observer drops some bodies then these remain relative to him in a state of rest or of uniform motion . . . . The observer therefore has the right to interpret his state as ‘at rest’ . . . and his environment as field-free relative to gravitation.
>
> The experimentally known matter independence of the acceleration of fall is therefore a powerful argument for the fact that the relativity postulate has to be extended to coordinate systems which, relative to each other, are in non-uniform motion.[80]

Thus was Einstein led to the general theory of relativity by a refinement of the representation in everyday thinking of the sensory experience of force.

If we look at what scientists do, we find that they move easily between theoretical and observational language, which form part of a single language (‘language’ here stands for thought, as publicly expressed); in fact the distinction between the two is hardly noticed, except in talk *about* what scientists do. The same seamlessness occurs between perception and conception in everyday thinking. We look at a human face, and we see its honesty, or its beauty. A physicist looks at a trace in a cloud chamber, and he sees the path of a subatomic particle. A stone age man sees the wrath of the gods in the sky ablaze with lightning and resounding with thunder. As these experiences appear to result from processes akin to the accretions of theory upon theory described above for science, it seems reasonable to analyse them by reference to such processes. Thus in the case of the human face we might say that what we perceive is a face, and to that we apply the concept of honesty. This way of putting it is not necessarily a faithful description of the neurological perceptual proc-

[80] Albert Einstein, “Grundgedanken und Methoden der Relativitätstheorie in ihrer Entwicklung dargestellt”, p. 178. Italics as in the original.

ess or the conscious observational process. For example, it is suggested by the neurologist, Susan Greenfield, in writing about the impairment of visual recognition called agnosia, that

> . . . understanding and seeing are not two separate processes but rather they are inextricably linked: if you see something you will automatically identify it. On the other hand, if you do not see an object in front of you, . . . [that] is because there has been a collapse of the higher integrative processes for complex form recognition in the visual cortex. Obviously you will not recognize the object.[81]

That is, perception and conception form a single process.

What is the appropriate description of observation for the purpose of understanding its role in science?

3. The Observational Base of Science

Summary: *Observation has conceptual content. Science emerges where concepts change from being sense and culture based to being scientifically informed. Scientific concepts are independent of human concerns but are provisional, while non-scientific concepts reflect human concerns but are taken as given. Paradoxically it is science, independent of the human, that reveals the human dimension of its own base. Philosophers have responded by seeking a secure observational base.*

In the previous section it was suggested that ‘observation’ and ‘theory’ are relative terms, that observation is where theory finds its immediate grounding, but that observation may itself incorporate theory from another related field of scientific enquiry or from well established theory in the same field. The main reference point in this progression is where the theoretical content of observation changes from the sense and culture based concepts of “everyday thinking” to scientifically informed concepts; this is where ‘observation’ changes from its traditional sense used by philosophers (Francis Bacon for example) to the more general sense used by scientists (permitting the observation of subatomic particles, for example). The ‘reference point’ in this progression refers of course to a loosely defined region rather than to a mathematical point, because as science infiltrates culture, concepts can become both culture based and scientifically informed. What we have in mind is that sense and culture based concepts are those by which the world is comprehended without those concepts normally being questioned (except by philosophers and scientists), whereas scientifically informed concepts are those constructed by the scientific enterprise for comprehension of a world extended beyond that of everyday experience by scientific means, both experimental and theoretical—

[81] Susan Greenfield, *The Human Brain*, p. 62

by the telescope, the microscope, atomic theory, etc. In contrast to everyday concepts, scientific concepts and theories, because of their more deliberate construction, are recognized as provisional or approximate. This is not to say that everyday concepts are not subject to change; but the change is evolutionary rather than systematically pursued, as with science.

Another difference between everyday and scientific concepts is that everyday concepts derive from not only human concerns, transient as they may be, but from the human condition, with its own particular focus on survival and the sensory mechanisms for ensuring it, whereas scientific concepts are concerned with what is universal and independent of human concerns (except in so far as science studies them). The conceptual element in observation would not be significant if observation were unmediated. But observation is mediated by conception; or, more precisely, by physiological processes giving rise to representations whose conscious aspect is conceptual. Thus science, the study of the universal, supposedly finds its foundation in observation that is mediated by concepts with a very human dimension. How, we may ask, is science able to transcend this conceptual dependence? In an attempt to resolve this question, and as part of the philosophical quest for absolute foundations for knowledge, philosophers have sought an unmediated observational base for science, the observational act free of conceptualization. Paradoxically, any such quest is undermined by the fact that it is science itself that reveals the mediated nature of observation and hence the mediating influence of concepts on its own observational base. Consider Bertrand Russell's rather stark description of this supposed paradox:

> Scientific scripture, in its most canonical form, is embodied in physics (including physiology). Physics assures us that the occurrences which we call "perceiving objects" are at the end of a long causal chain which starts from the objects, and are not likely to resemble the objects except, at best, in certain very abstract ways. We all start from "naïve realism", i.e., the doctrine that things are what they seem. We think that grass is green, that stones are hard, and that snow is cold. But physics assures us that the greenness of grass, the hardness of stones, and the coldness of snow, are not the greenness, hardness, and coldness that we know in our own experience, but something very different. The observer, when he seems to himself to be observing a stone, is really, if physics is to be believed, observing the effects of the stone upon himself. Thus science seems to be at war with itself: when it most means to be objective, it finds itself plunged into subjectivity against its will. Naïve realism leads to physics, and physics, if true, shows that naïve realism is false. Therefore naïve realism, if true, is false; therefore it is false.[82]

For 'naïve realism' read 'observation not mediated by human conceptual makeup' ("things are what they seem"): thus Russell argues that observation

[82] Bertrand Russell, *An Inquiry into Meaning and Truth*, p. 15

cannot be concept free in this sense.

Einstein, in his characteristically generous and gracious way, says that "these lines say something which had never previously occurred to me", and writes in response:

> . . . Russell's just cited remark uncovers a connection: if Berkeley relies upon the fact that we do not directly grasp the "things" of the external world through our senses, but that only events causally connected with the presence of "things" reach our sense organs, then this is a consideration which gets its persuasive character from our confidence in the physical mode of thought. For, if one doubts the physical mode of thought in even its most general features, there is no necessity to interpolate between the object and the act of vision anything which separates the object from the subject and makes the "existence of the object" problematical.[83]

Einstein states, in effect, that physics is true (using Russell's form of words) if and only if naïve realism is false; and as he takes physics to be true (c.f. "our confidence in the physical mode of thought"), naïve realism is false.

Philosophy and science respond to the problem as to how science transcends its dependence on an observational base mediated by human concerns in two distinctive ways, which we shall now consider.

4. The Philosophical Quest for Observational Certainty

Summary: Both rationalists and empiricists have sought an indubitable base for knowledge, rationalists in individual thought and empiricists in individual observation. The empiricists' idea was to identify an indubitable observational base from which all observed entities, or at least the observation thereof, could be constructed. Because of the inherent uncertainty in observation of mentally external phenomena, indubitable bases proposed were mentally internal, sense-data and seeming-to-observe being two considered here. It is shown that such mentally internal observational bases, if indubitable, cannot act as indubitable observational bases for science.

It has been distinctive of philosophy to seek certainty. For both rationalists and empiricists the problem has been the way in which we acquire knowledge. The rationalist approach derived originally from Plato, and was concerned with the uncertainty of knowledge obtained from the senses in contrast with the apparent certainty of knowledge obtained from individual thought processes. The ideal was Euclidean geometry, seemingly derived from our own thought and yet constituting absolute knowledge of the world. Descartes sought to apply this method to natural philosophy, his results being expounded in the *Principles of Philosophy*, referred to in Part I. He was concerned to show that the principles upon which he based his philosophy were

---

[83] Albert Einstein, "Remarks on Bertrand Russell's Theory of Knowledge", p. 21

beyond doubt, were indubitable. As all knowledge appears to begin with the individual, the starting point for showing indubitability was his own existence: how can the argument from illusion, and the scepticism of our very existence which this suggests, be answered? Descartes was convinced that his own existence follows from the fact that he was engaged in thought; and because knowledge that we are thinking is indubitable, our existence is also indubitable. Now 'I think, therefore I exist' is undeniable in the same way as an axiom of geometry is undeniable: it reflects the way in which the words 'think' and 'exist' are used in rational discourse, just as 'a straight line can be drawn between any two points' reflects the way in which the terms 'straight line' and 'point' are used in geometrical descriptions. But the existential inference is empirical, as Descartes could not have realized, just in the way that geometry has been found to be empirical, for rational discourse using the words 'think' and 'exist', or their scientific refinements, depends on the success of such discourse in the empirical world, in the public arena.

The idea that knowledge is obtained from indubitable individual experience was also subscribed to by the empiricists, but in a different way from the rationalists. The empiricists believed that all knowledge of the world comes from the individual experience of it, from observation. The question that concerned the empiricists, and has concerned their later successors, was therefore how knowledge is obtained from experience of the world—what is the nature of observation? The experience upon which knowledge is based was what Locke called 'ideas', Hume called 'impressions', and Russell and other analytic philosophers called sense–data. There is an echo of this in Russell's assertion, quoted above, that the observer, in seeming to himself to be observing an object, is really observing, not the object itself, of whose existence he can never be absolutely certain, but the causal effect of the object, or whatever it might be, on himself. From individual observational experience knowledge of the world is built up in some way, as a logical reconstruction in terms of sense-data, for example, of ordinary discourse about observed objects. With Locke's theory of ideas what was being attempted was a description, formal rather than physical, of the processes of observation occurring within the individual observer. A consolidation of the empiricism of Locke, Berkeley and Hume appeared in the phenomenalism of Mach, who regarded the world as consisting only of sensations, or 'elements', as he called them, in terms of which it is the business of science to construct concise descriptions of phenomena, that is, of appearances of the world.[84] With the advent of linguistic phenomenal-

[84] For example, Peter Alexander writes, in "Mach", p. 116: In regard to Mach's sensationalism, his most obvious debt is to Berkeley and Hume, since he based his whole philosophy of science upon the conception of "elements" or "sensations", which is a developed and refined form of the eighteenth-century empiricists' "ideas" and "impressions".

ism, stimulated largely by the logical advances of Frege and Russell, the problems of observation were translated into linguistic and logical terms. This proved a difficult challenge, as the philosophical progress of its most industrious advocate, Carnap, illustrates. Influenced by Mach and Russell, Carnap first proposed (in his *Logical Construction of the World*) a formal system for observation based on individual mental experiences to which all observation could, in principle, be reduced (in the sense of reduction by which thermodynamics is reducible to statistical mechanics). Persuaded by Neurath, Carnap revised the proposed observational base from mental experiences to physical protocol statements, that is, statements of irreducible physical events to which all of physics could be reduced, and hence all of science by reduction to physics. Carnap's third position was as outlined at the end of this section and an abandonment of reduction in favour of confirmation, as discussed in Section 6. For the purpose of evaluating these philosophical approaches to understanding observation, we shall consider the example of Russell's 'seeming to observe'.

Suppose that an observer is in a state of seeming to himself to be observing a stone. Let us call this state an observing-state; in this case a stone-observing-state. Russell states that the observer is "observing the effects of the stone upon himself". He also says that occurrences of "perceiving objects", for example the stone-observing-state, is at the end of a causal chain starting at the object, for example the stone. As what is at the end of a causal chain is an effect, presumably the effect of the stone is the stone-observing-state. It follows that for Russell the observer is observing the observing-state.

Russell says that the observing-state is likely to resemble the object causing it only in "very abstract ways". The word 'resembled' suggests the idea of copying from the object to its observational effect, an idea that does not cohere with the process under consideration, and will be considered in Section 6. Perhaps all we should take from this statement of Russell's is that the stone-observing-state may not be caused by a stone at all—the observing-state may be an illusion or a mistake. How, then, can we account for a stone-observing-state without a stone to cause it? We could say this: an observing-state is caused by certain stimuli which the observer, in assuming that state, interprets in a certain way; in assuming a stone-observing-state the observer is interpreting the stimuli as if they had originated in a stone. It follows from this that a stone-observing-state is the same state irrespective of whether or not there is a stone observed. It should also be noted that an observing-state carries with it a psychological conviction as to the identity of an observed object.

The conclusion that the observer is observing the observing-state is not uniquely Russell's, but is common amongst empirically minded philosophers, for it answers to their need to take account of illusions and mistakes in observation, and at the same time to identify indubitable observational foundations for knowledge. Thus Ayer writes:

> When, however, one turns to the writings of those philosophers who have recently concerned themselves with the subject of perception, . . . they are not, for the most part, prepared to admit that such objects as pens or cigarettes are ever directly perceived. What, in their opinion, we directly perceive is always an object of a different kind from these; one to which it is now customary to give the name of "sense-datum". These sense-data are said to have the "presentative function"[85] of making us conscious of material things.[86]

Here the indubitable observational elements are sense-data. The idea that there is observation of an observing-state, or of sense-data, looks very like Descartes's dualist idea that there is a homuncule, a soul or mind, viewing the image that is produced by the observed object on the retina of the eye, or on the pineal gland (as Descartes thought), or wherever apparently insurmountable difficulties first appear in our comprehension of the functioning of the brain. Perhaps, though, we could at least allow that one can in some sense, if not in an observational sense, be aware of an observing-state. However, if the awareness and the observing are simultaneous, as presumably is envisaged, then it would seem that the unity of consciousness should dictate that they be parts of a single state of awareness, in which case awareness of an observing-state cannot be distinguished subjectively as distinct from the observing-state, though there may be distinct physiological components making up the single state—awareness of an observing-state does at least appear to be logically distinguishable from the observing-state.

In that case let us consider whether the existence of the observing-state provides indubitable knowledge of scientific value. It can surely be said that a subject is, or can become, aware_2 that (and when) he is in an observing-state, which is a state of awareness_1 of the world and himself in it and of his own condition, whether the observing be veridical or not: he can be aware_2 that he is aware_1. For example, I can become aware_1 of an injury to my foot (though it may or may not in fact be injured) by means of a pain in my foot, the pain being the mode of awareness_1 and thus part of my observing-state. And I can be aware_2 that I have a pain in my foot. Now surely my awareness_2 of the pain constitutes indubitable knowledge, though the pain is not an indubitable indication of injury. That is, if I am aware_2 of a pain, then is it not certain that I have a pain? And if I am aware_2 of being in a stone-observing-state, then can I be otherwise than in a stone-observing-state? The answers to these questions depend on how the two states are related. Certainly awareness_1 that there is a

---

[85] Cf. H.H. Price, *Perception*, p. 104.

[86] A.J. Ayer, *The Foundations of Empirical Knowledge*, pp. 1, 2

stone before me does not imply that there is a stone before me. Why, then, might awareness$_2$ that I am in a particular state imply that I am in that particular state? Perhaps because, as both states are states of my consciousness, they are, by the unity of consciousness, aspects of the very same state—they coexist in a single state of consciousness. If so, then can we speak of awareness$_2$ as constituting a distinct item of knowledge? Is it not the state of which it forms a part (and of which the observing-state is another part) the entity to which knowledge can be attributed? If it is, then that combined state of awareness$_2$ and awareness$_1$ cannot, because of its observational component, be indubitable. The terms in which this analysis is expressed appear to be insufficiently well defined and insufficiently clear in their reference to admit of a definitive conclusion on either logical or empirical grounds. Fortunately decision as to the existence of an indubitable base for science is not affected by this difficulty. For if awareness$_2$ of an observation is not indubitable, then it cannot be a candidate for an indubitable base. On the other hand, if it does constitute indubitable knowledge, it can easily be shown, as follows, that that knowledge cannot form an indubitable base for science.

Consider my observing-state concerning a stone, which may or may not be veridical. If I report on my observing-state, then others are in a position to form their own independent observing-states concerning the supposed stone and its properties and to issue their own reports on their observings. These reports and mine can then be correlated so as to ascertain the existence and properties of the stone. The object of these observing-states, the stone, then becomes an object of public knowledge. It is with such public knowledge as this that science is concerned —the most obvious evidence of this is in the reports submitted to the public arena of scientific journals and conferences, where the validity of their claims may be tested. Now suppose that I report my, supposed indubitable, awareness$_2$ of my observing-state. For this to be of value to science as indubitable knowledge, my observing-state would need to become an object of public knowledge by means of the issue of reports of others' indubitable knowledge of my observing-state. But while others may become aware of some aspects of my observing-state, by reading my report, observing my behaviour or examining my brain, that awareness would not be indubitable, for no one has the privileged access to my conscious experience that I have, and in any case would certainly not exist in the detail of my own awareness. It follows that awareness of observing-states, if indubitable (from the point of view of the observer), cannot form an indubitable base for science, or indeed for empirical knowledge in general (and, it should be added, for my own actions, for indubitable as awareness of my own thought processes might be, it is of limited use as a source for my knowledge of the world).

We may as a consequence of this discussion venture the general conclusion that the philosopher's quest for an indubitable base for knowledge cannot be otherwise than fruitless.

In view of difficulties with sense-data and suchlike as objects of public knowledge, philosophers have put forward as basic observational entities, in Carnap's words[87], "properties [of objects] directly perceived by the senses", such as "blue", "hard" and "hot"; or in the case of the intensity of an electric current, for example, the pointer reading of an ammeter rather than the intensity of the current itself. Perhaps one could substitute a colourimeter for measuring colour, a Rockwell machine for measuring hardness, a thermometer for measuring hotness, and so on, so that in this way all observations could become the readings of pointers or digital displays of measuring instruments designed on scientific principles. What this does is to enable science to penetrate into observational practice, thus reducing the influence of ordinary human practices on the scientific structure. This turns out to be just part of the process by which science frees itself from its base in naïve realism, and moves toward, not absolute knowledge of a philosophical kind, but universal knowledge of a scientific kind.

5. The Scientific Refinement of Observation

Summary: Science achieves independence of human concerns by repeated scientific refinement of its observation base in everyday experience. The repetition is an iterative process by which each refinement is used to assist in achieving the next one. This process enables science to penetrate into its observational base and free it of its unwanted human orientation. At the same time it enables the laws of science to be subjected to improved testing, and refined or replaced accordingly. New laws in turn redefine the terms under which the observational base is established. The convergence of the base through iteration does not imply a like convergence of the laws.

Given the conclusion of the previous section, how can science achieve independence of human concerns while remaining dependent on observation with a human conceptual content? For an answer to this we return to Einstein, and in particular to his idea that "the whole of science is nothing more than a refinement of everyday thinking". Einstein's genius lay in his capacity to reformulate the basic conceptual ingredients of physics—time, space, mass, energy, gravitation—by taking them back to their roots in our ordinary perception of the physical world, as with "the happiest thought of my life" (see above). It is probably with such reformulations as this that his idea about the refinement of everyday thinking was concerned. Rather than pursue Einstein's idea amongst his writings, let us see how it can be developed in a general way to

[87] Rudolf Carnap, *An Introduction to the Philosophy of Science*, pp. 225-226

account for the emergence out of our everyday concerns of a science concerned with the universal. In brief, the idea is not that the human conceptual content of observation should be eliminated, but that it should be refined in accordance with scientific knowledge.

This refinement is achieved by the method of iteration. 'Iteration' means repetition, and is fundamental in mathematics. Let us look briefly at its use there. Very few quantities in mathematics can be expressed in terms of ratios of whole numbers, that is, as rational numbers. Because whole numbers and their ratios were the only form of number recognized by the Greeks, an irrational number such as $\sqrt{2}$ was for them not a number. But it is a number for us, for we have created it[88], and we can approximate it by rational numbers as closely as we please by the method of iteration. (It is also possible to define $\sqrt{2}$ as the limiting value of an iterative procedure.) There is no single method of iteration for calculating $\sqrt{2}$: in order to illustrate iteration, here is one such method. Start with a rough approximation, say $x_0 = 1$. Calculate $x_1 = x_0/2 + 1/x_0$, $x_2 = x_1/2 + 1/x_1$, $x_3 = x_2/2 + 1/x_2$, and so on. Each iteration uses the same calculation procedure, but applied to the result of the previous iteration (for x_1, applied to the starting approximation). Note that the members of the sequence are rational numbers. The first few numbers generated in this way are, to six decimal places:

$$x_0 = 1$$
$$x_1 = 1.500\,000$$
$$x_2 = 1.416\,667$$
$$x_3 = 1.414\,216$$
$$x_4 = 1.414\,214$$

Thereafter no change occurs in the first six decimal places; that is, x_4 approximates $\sqrt{2}$ to six decimal places. This example illustrates the principal features of iteration: it is repetition of a procedure applied to results obtained by previous application of the procedure. It can be seen that choice of an appropriate procedure may result in rapid convergence. For our purpose a sufficiently general form for the method of iteration is, starting from x_0, to obtain $x_{n+1} = P(x_n)$ by some process P applied to x_n for n=0, 1, 2, . . . , where $x_0, x_1, \ldots$ are elements of some class of objects for which a metric exists by which convergence of the sequence $(x_0, x_1, \ldots)$ can be defined. Note that the convergence does not imply the existence of a limit lying in the class to which the elements belong; thus the limit of the above sequence of rational numbers, $\sqrt{2}$, is not a rational number. However, the convergence of $(x_0, x_1, \ldots)$ may

---

[88] Richard Dedekind created it: he defined $\sqrt{2}$ as the ordered pair of sets of rational numbers (Dedekind cut), $(\{x : x^2<2\}, \{x : x^2>2\})$. In effect, $\sqrt{2}$ is defined as the point where the rational numbers are cut into the two sets. See E.T. Bell, *Men of Mathematics*, p. 519.

enable an extension of the class to be so constructed that it contains such a limit; for example, the rational number field can be extended to the real number field, which contains $\sqrt{2}$. Note that if $(x_0, x_1, \ldots)$ converges then the limit is independent of the starting approximation x_0, provided that x_0 is sufficiently close to the limit: the limit is a solution of the equation $x = P(x)$. Note also that if there is another sequence $(y_0, y_1, \ldots)$ associated with $(x_0, x_1, \ldots)$ for which $y_{n+1} = Q(y_n)$, where Q is a procedure associated with P, it does not follow from the convergence of $(x_0, x_1, \ldots)$ that the sequence $(y_0, y_1, \ldots)$ also converges. For example, if $x_0 = y_0 = 1$, $y_{n+1} = -y_n$ and $x_{n+1} = \frac{1}{2} x_n y_n$ for $n \geq 0$, then $(x_0, x_1, \ldots) = (1, -\frac{1}{2}, \frac{1}{4}, -\frac{1}{8}, \ldots)$ converges but $(y_0, y_1, \ldots) = (1, -1, 1, -1, \ldots)$ does not.

Mathematical iteration is introduced as a point of reference for a terminology that may be usefully applied in more loosely structured non-mathematical investigations, in particular the one in which we are presently interested. Accordingly, we shall now consider the use of iteration in a particular case in the development of physics, that of the measurement of time.

Prior to modern science a variety of naturally occurring regularities were used to keep time: for example, the flow of water, oscillating rods, and astronomical movements. These were found to suit man's need of a regular motion—abstracted to the uniform passing of time—by which to organize the routines of his life, in so far as they conformed roughly to each other and to the rhythm of life. Water clocks were used up to the time of Galileo (1564–1642), who in his experiments on objects falling under the force of gravity used the flow of water through a tube attached to the bottom of a large container to measure time.[89] Let us denote these primitive types of clock by C_0, and the everyday thinking with which they were associated by L_0 (L for law or theory). What Galileo did was to use C_0 in the discovery of new laws L_1, in particular those concerning falling bodies, from which he obtained the period of a pendulum. In 1657 Christaan Huygens produced the pendulum clock, the first of a more accurate class of clocks, C_1. Here is identified a process, P, by which C_1 is obtained from C_0 by way of the development of the new law, L_1, which was enabled by C_0: thus $C_1 = P(C_0)$. C_1 in turn assisted Newton's consolidation of mechanics to be established, and from further advancements in knowledge associated with this there was developed law L_2, and thence a more accurate class of clocks, C_2: thus we write $C_2 = P(C_1)$. The sequence can be represented:

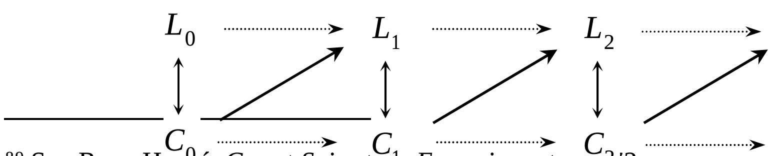


FIGURE 2

[89] See Rom H é, *Great Scient Experiments*, 2.

In each case the clock based on the new law enabled the terms in which the law is framed, in particular time, to be fixed more precisely, the law to be subjected to test, and thence a further law developed.

It is important to recognize that the replacement of C_0 by C_1 via L_1, of C_1 by C_2 via L_2 and so on were not just technological developments enabled by scientific progress: they were part of the process by which the terms of that progress were defined. Consider the construction of more accurate pendulum clocks C_2 in place of Huygens's pendulum clock C_1. By what criterion should C_2 be considered more accurate in measuring time than C_1? Criteria are not God-given, but are created in response to empirical investigation. In this case the answer lies in the Newtonian mechanical system of laws, L_2. In his *Principia* Newton writes of time:

> Absolute, true, and mathematical time, of itself and from its own nature, flows equably without relation to anything external, and by another name is called 'duration'; relative, apparent, and common time is some sensible and external (whether accurate or unequable) measure of duration by the means of motion, which is commonly used instead of true time, such as an hour, a day, a month, a year.[90]

'Absolute, true, and mathematical time' is the abstraction of time with which Newton's theory of mechanics is concerned. 'Relative, apparent, and common time' is a measure of absolute time 'by the means of motion', where motion must, of course, conform to Newton's mechanical principles. Suppose that the motions of identical mechanical systems differed between two different locations when measured by a clock of type C_1 but not by a clock of type C_2. Then we could say that the former clock does not measure absolute time but, at least by this test, the latter clock does. For example, a C_1 type clock gives different measurements of elapsed time for the supposedly constant sidereal day at different latitudes (due, according to Newtonian mechanics, to variation with latitude of the gravitational force exerted by the earth); a C_2 type clock gives the same measurement of elapsed time (because it is corrected for the gravitational effect). The criterion for considering C_2 more accurate than C_1 is thus that time as measured by C_2 gives a confirmation of Newtonian mechanics, in the correction applied by means of it to produce C_2 from C_1. That is, the conceptual content of the observation of time has been changed in conformity with scientific theory. A further change occurred when, with the aid of C_2, discrepancies were discovered between the observed orbit of the planet Mer-

[90] Isaac Newton, *The Mathematical Principles of Natural Philosophy, Scholium 1*

cury and predictions made on the basis of Newtonian mechanics. These discrepancies, together with difficulties with the Newtonian concepts of absolute time and space, as well as relativistic considerations applied to gravitation (mentioned earlier), led to Einstein's theories of relativity, L_3, which contributed to the development of clocks C_3 conforming to those theories. Ernest Nagel writes about this iterative process:

> A definite advantage has thus been obtained from the adoption of a new timekeeper. For in consequence of this change, dependencies are discovered between the periods of various processes which might either have escaped our attention entirely had we retained the old clock or have required formulations so complex as to make them practically worthless. But it is obvious that there is no necessary limit to this process of abandoning one standard measure of time in favour of another, and that further gains may be won if the pendulum is replaced by, say, the rotating earth as the standard clock. The procedure here outlined illustrates what has been called the process of "successive definition", a process repeatedly encountered in the history of modern science.[91]

This is the way in which a succession of developments in scientific theory and concomitant developments in observational practice occur in unison, which we have for purposes of exposition represented by the sequence $C_1 = P(C_0)$, $C_2 = P(C_1)$, . . . , where P stands for the process of theoretical development referred to. It is of course to a large extent arbitrary how the divisions of the sequence are defined. However it is done, it is clear that the sequence of laws associated with the sequence of clocks can be represented in a similar way: $L_1 = Q(L_0)$, $L_2 = Q(L_1)$, . . . , where Q is the process of scientific infiltration of observations enabling development of scientific theory. With the mathematical example of iteration in mind, it might be expected that the sequence (C_0, C_1, . . .) generated by the relation $C_{n+1} = P(C_n)$ would show evidence of convergence. A metric for convergence might be the accuracy of C_n in measuring time. Time as measured by C_n, however, is a concept that takes its meaning from theory L_n . However, the accuracy of any of C_0, C_1, . . . , C_n can be judged according to L_n (or perhaps equivalently, any L_m for $m \geq n$), so notionally we may write $\|C_i - C_j\|$ as a (numerical) measure of the closeness in accuracy of C_i and C_j for $i, j \leq n$. (Formally, we might define the sequence (C_0, C_1, . . .) to converge if and only if, given any number $\varepsilon > 0$, there is a number N such that, for all $n > m > N$, $\|C_n - C_m\| < \varepsilon$ according to L_n .) If, for example, L_n is taken to be relativity theory, then the sequence of clocks from the water clock to the atomic clock shows evidence of convergence in accuracy of time measurement judged by L_n. That there is a notional convergence of the sequence (C_0, C_1, . . .) does not mean either (a) that there is an actual clock to which the sequence

[91] Ernest Nagel, *The Structure of Science*, p. 180

converges, or (b) that there is also a convergence in the sequence (L_0, L_1, . . .). (a) is just a confirmation that convergence does not imply reality of limit, or reality *in* the limit, as scientific realists maintain. (b) does not say that there is no convergence for (L_0, L_1, . . .), only that none is implied. And convergence is not indicated by the historical evidence, which shows periods of convergent normal science (in Kuhn's terminology) punctuated by revolutionary jumps—relativistic mechanics is far from Newtonian mechanics in formal structure despite its many observational convergences.

Iteration, or "successive definition", has a general application to science. It is the method whereby science becomes more and more abstract, where concepts once formulated on the basis of everyday experiences gradually lose their everyday associations, new concepts are developed which owe their meaning primarily to their theoretical role, including theory employed in experimental observation, and thus a scientific language comes into existence. This is how science seeks a base from which to achieve universality of application; not in some philosophically absolute construction, but in a procedure by which the base is progressively refined in the light of developing theory. The formalism used for the development of clocks can be adapted to express this last point, with *C* for clock replaced by *O* for observation:

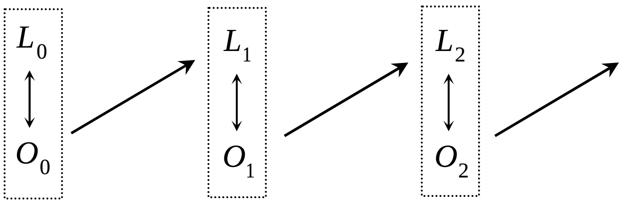


FIGURE 3

The direction of the arrow shows the dominant, though not exclusive, influence. How does Russell's argument for the falsity of naïve realism, quoted in Section 3, fit into this scheme? The argument is: naïve realism → physics → ~naïve realism. Corresponding to the pair (O_n, L_n) let us separate out from L_n the derived mind–world relationship R_n , with R_0 being naïve realism.

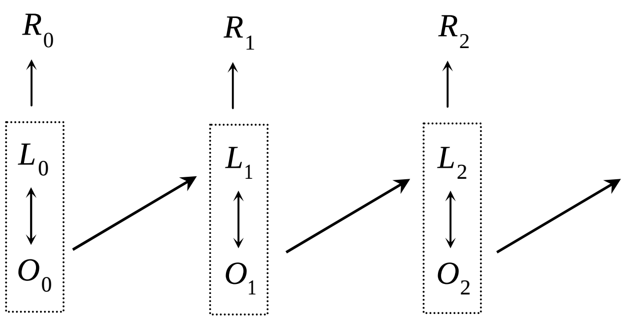


FIGURE 4

Does R_n have any influence on L_n? On the evidence of Part I it would appear not; hence the representation of R_n in the diagram. It follows that Russell's statement that naïve realism, R_0, leads to physics, (O_1, L_1), is wrong. Russell is confusing the statement of naïve realism, that "things are what they seem", with statements of fact, made by a naïve realist, upon which physics is based. But the pair (O_0, L_0), which might be dubbed 'common sense and folk science' and from which R_0 derives, leads to $(O_1, L_1) \rightarrow R_1 \rightarrow {\sim}R_0$. Thus naïve realism is shown to be false not on philosophical grounds, but as an implication of science.

In Section 4 it was shown that there is no indubitable observational base for science. Thus in view of the conclusions of Section 5 it cannot be expected that there would be a point beyond which scientific refinement of the conceptual content of observation does not penetrate. The question as to how science relates to the world devolves, then, on how the mind relates to the world. It was observed in Section 3 that 'observation' and 'theory' are relative terms that obtain their meaning from the context of their use in scientific practice. The question that arises here is how observation and theory are related; in particular, how theory and theoretical terms are established on the basis of observation. These issues are now examined.

6. Mind and the World

Summary: The relation of mind and world is investigated. It is epitomized in the question of how we see, for which the physiology of vision does not provide an adequate answer. To answer the question requires an understanding of how the mental constructs of the visual process relate to the world. They cannot be said (except obliquely) to resemble the world, as there is no independent way of knowing the world. It is put forward as a proposition of fact that the world as we know it is 'given' by its mental representations. The nature of representation, its relation to sensory input, and the actions that may ensue from it are intimately connected. At the neurological level, a possible mechanism for generating representations is by selection from possible neurological connections.

There are issues concerning mind and the world, and analogously science and observation, that have been of central importance to philosophy since its beginning. They have been touched on in the preceding discussion and will now be addressed directly.

First let the assumption be stated again under which this investigation is being conducted: given the reach of modern scientific knowledge, philosophical problems concerning mind and the world derive essentially from difficulties in finding a mode of description of known facts suitable for critical analysis of the problems, due in large measure to the ancient roots of both philosophical and ordinary language, and its dissociation from the kind of language in which these facts can be adequately comprehended and new facts accommodated, the kind of language used by science.

The central problem for the philosophy of mind, the relation of the mind to the world, and the philosophy of science, how scientific theory relates to scientific observation, are epitomized in the seemingly simple question: What is it to see? Until we have thought about it, this seems to be a superfluous question, for is it not only the blind who do not know what it is to see? On being acquainted with the main facts about the visual system, we are quite likely to be satisfied with the answers they give, in so far as they reflect current knowledge. This response, however, is not justified, as Francis Crick writes in *The Astonishing Hypothesis*:

> There are two rather surprising aspects of our present knowledge of the visual system. The first is how much we already know—by any standards the amount is enormous. . . . This knowledge has been acquired by the painstaking efforts of many experimenters and theorists, over many years, studying both humans and animals.
>
> The other surprising thing is that, in spite of all this work, we really have no clear idea how we see anything. . . . we do not yet know, even in outline, how our brains produce the vivid visual awareness that we take so much for granted. We can glimpse fragments of the processes involved, but we lack both the detailed information and the ideas to answer the most simple questions: How do I see colour? What is happening when I recall the image of a familiar face? and so on.
>
> But there is a third surprising thing. You probably already have a rough-and-ready idea of how you yourself see things. . . . "you" put together the pictures coming to your brain from your two eyes, and so you see. Without thinking about it, you probably have some idea how this might happen. What may surprise you is that, even if scientists still do not know how we see things, it is easy to show that how *you* think you see things is largely simplistic or, in many cases, plain wrong.[92]

Crick apparently believes that, apart from simplistic notions of vision, the deficiency in our understanding of vision lies in our lack of knowledge of the neurological processes involved. This is consistent with the "Astonishing Hypothesis" of the title of his book, that

> "You", your joys and your sorrows, your memories and your ambitions, your sense of personal identity and free will, are in fact no more than the behaviour of a vast assembly of nerve cells and their associated molecules.[93]

Crick's hypothesis is the well known identity theory of the mind, that mental events are identical (in some sense) to neurological processes. This theory seems to leave something unaccounted for, as it seemed to Leibniz nearly three hundred years ago:

> 17. We are moreover obliged to confess that *perception* and that which depends on it *cannot be explained mechanically*, that is to say by figures and motions. Suppose that there were a machine so constructed as to pro-

[92] Francis Crick, *The Astonishing Hypothesis*, pp. 23, 24

[93] Crick, *op. cit.*, p. 3

> duce thought, feeling, and perception, we could imagine it increased in size while retaining the same proportions, so that one could enter as one might a mill. On going inside we should only see the parts impinging upon one another; we should not see anything which would explain a perception. The explanation of perception must therefore be sought in a simple substance, and not in a compound or in a machine.[94]

Leibniz fills in the missing element in perception with monads. Crick supposes that we have a natural inclination to fill it in with an unexplained "you", a Cartesian homuncule, which he summarily dismisses as "plain wrong". But surely both Crick and Leibniz are right in this, that vision is nothing but neurons, but neurons alone do not seem to explain vision. If Crick means to say that there are neurological correlates for vision, as no doubt he does, then would not finding those correlates and describing them in a suitable way afford an explanation that should satisfy us?

The neurophysiologist, Rudolfo Llinás, acknowledges the need for such an explanation, and proposes one:

> As a neuroscientist, the single most important issue one can address concerns the manner in which brains and minds relate to one another. It is thus quite surprising that this issue attracts so little interest in our field. . . .
>
> I for one, as a monist, consider 'mindness' (by 'mindness' I mean high-level awareness, including self-awareness) to be but one of several global physiological computational states that the brain can generate. . . . the 'mindness state' allows complex goal-directed interactions between a living organism and its environment. The more complex the interaction the more involved the 'mindness' state—and yet, it seems to me, never so complex as to transcend the boundaries of the purely material. . . .
>
> In order to put this issue into context, we may ask, for instance, 'How do we see?' Indeed, among the many upsetting experiences encountered as a professor of physiology at a medical school, one in particular is relevant here. It relates to a student who, having been particularly interested in our teaching of the nervous system, said, 'But, now that I have learned neuroscience, I find that I still do not understand, for instance, how I see'. The student may be able to recite the functional and anatomical properties of the visual system from retina to motor neurons and yet may say to me in all candour, 'I can follow the whole system and its properties but I still have no conception at all of what it is to see'. This problem arises because we forget to tell our students that seeing is reconstructing the external world, based not on the reflecting properties of light on external objects but, rather, on the transformation of such visual sensory input (a vector) into perception vectors in *other sets of coordinate systems*. Indeed, we should have reminded our students that in order to see one requires first to have moved within the world and to have established, via the use of natural coordinates, the properties of objects with respect to our own physical attributes (the weight of each object, its size with respect to that of our body, etc.). It would

[94] G.W. Leibniz, *Monadology*

> be clear then that it is only through the ability that our brain has to transform measurements in one set of coordinates (the visual system) into comparable sets of measurements (visually guided motor execution) provided by other sensory inputs (for example, touch from fingertips) that one can truly develop the necessary semantics to be able to understand what one sees. The point is that understanding the functional connectivity of the visual system is not sufficient for understanding vision.[95]

Two important propositions can be drawn from this quotation.

(1) Vision is a reconstruction of the external world. Elsewhere Llinás expresses this in striking terms:

> The sensory input feeds and modulates an internal state of intrinsic origin, that is, perception is a dream modulated by sensory input.[96]

(2) Vision is only one part of the process by which that reconstruction takes place, for it must be complemented by other sensory modes and it must be exploratory, it must be integrated with movement.

The first proposition is obvious when one thinks about it for a moment: seeing involves having a vision of things; where else could the vision be but in ourselves? The whole of the visual field that appears to be before our eyes is formed within ourselves! Which, of course, is not to say that the things visualized are in ourselves. Llinás goes further by proposing a mathematical model for the reconstruction, which produces a homomorphism (a many-to-one form preserving mapping) from the space of external reality as represented by sensory input onto the space of internal functional states. Thus

> . . . one may say that mind is a computational state of the brain generated by the interaction between the external world and an internal set of reference frames. These latter frames are generated, initially, as an internal embedding of the body's natural coordinate systems.[97]

This proposal offers a neurological correlate of the mind, including vision, which gives a structural meaning to the 'is' of the identity theory of the mind.

With this kind of analysis before us, we ask again: Does such an analysis as this offer a sufficient explanation to satisfy us? Does it answer Leibniz's requirement? The generally accepted answer, at least amongst philosophers, is that some such explanation provides objective understanding of the mind–world interaction, but that it can never explain the subjective aspect of individual experience, of consciousness. We shall put aside the second issue for the present and concentrate on objective description.

Let us return to the observing-state of the mind (or the brain) of Section 4, which Bertrand Russell said is "at the end of a long causal chain which starts

---

[95] Rudolfo Llinás, "'Mindness' as a Functional State of the Brain", pp. 339, 351-352

[96] Llinás, *op. cit.*, p. 351

[97] Llinás, *op. cit.*, p. 351

from the objects" observed, but which is "not likely to resemble the objects, except, at best, in certain very abstract ways". But does it make any sense to speak of a perception of an object as resembling the object? By 'resemble' Russell is perhaps thinking of verisimilitude ("likeness or resemblance to truth", *OED*). Suppose I look at a tree. My vision of the tree, which is part of my observing-state, resembles the *appearance* of the tree, does it not? How could it be otherwise? In this way: suppose I look at an electricity pole (in dim light, and partly obscured) and see a tree. My vision of the pole, which is part of my observing-state, resembles the appearance of a tree. Now suppose I wish to check the object of my vision. I take a closer look, touch the pole, refer to my knowledge of poles and trees, perhaps ask someone else to have a look at it too, and so on. Thus that my vision of an object, my observing-state, resembles the object itself can only be taken to mean that my observing-state coheres with other comparable observing-states, those whose objects supposedly correspond to mine; and if the coherence is poor, so is the resemblance. In short, I check agreement of my observing-state with other observing-states, existing and newly generated, and information derived therefrom. It is what I can do as a result of my observing-state that gives 'resemblance' its meaning in this context. It is meaningless to speak of direct resemblance between a vision and its object, for the two, being of different categories, are not directly comparable for resemblance; they can be compared only indirectly in the manner described.

Notice that in the procedure described for deciding on resemblance between observing-state and object, we do not step outside the realm of observing-states—we cannot bypass observing-states to take a direct look at the object as a thing in itself, so to speak, for there is nothing that answers to the description, 'a direct look at a thing in itself'. This does not mean that we do not look at the outside world; for observing-states result from our response to sensory stimulation, coming both from within our bodies and from the external world, the world external to our bodies.

Let us ask, then, what is the relation between the observing-state and its object? And in general between any mental state and what it is about? This is the fundamental question concerning the relation between the mind and the world. The short answer is that the object inheres in the observing-state, as Franz Brentano wrote:

> Every mental phenomenon is characterized by what the Scholastics of the Middle Ages called the intentional (or mental) inexistence of an object, and what we might call, though not wholly unambiguously, reference to a content, direction towards an object (which is not to be understood here as meaning a thing), or immanent objectivity. Every mental phenomenon includes something as object within itself, although they do not all do so in the same way. . . . We can therefore define mental phenomena by saying that

> they are those phenomena which contain an object intentionally within themselves.[98]

Brentano's one-time student, Kasimir Twardowski, reaffirmed this:

> It is one of the best known positions of [descriptive] psychology, hardly contested by anyone, that every mental phenomenon intends an immanent object.[99]

The observing-state is a construct of the nervous system of the observer produced in response to sensory stimulation and utilizing existing information from his cerebral capacity. The construct utilizes a coordinate system within which the object and the observer are located, thus enabling the observer to project the object either beyond his own body and nervous system, or else within it, according to the nature of the sensory stimulus. This much is reasonably clear from our knowledge of the functioning of the nervous system, in particular vision. The details are not well understood however, mainly, it seems, due to lack of understanding of the organization of the existing vast store of information (memory) which is utilized in the construction of mental states. It would appear that mental constructs are organizing systems, some stable in time, others subject to continual change. There have been many models offered of the nervous system, becoming more detailed as knowledge accumulates, one of which is that of Llinás. Others are the holographic hypothesis of Karl Pribram[100] and the neural Darwinism promoted by Gerald Edelman[101] (see below).

To speak of the object of an observing-state inhering in the observing-state itself provides us with an understanding of vision as a constructive process. We appear to be left, however, with the unanswered question as to how the observing-state relates to the state of affairs in the world that it represents. The relation cannot be one of resemblance (in any direct sense), for the reasons given above. It should be clear from our discussion that what we should be asking is not how faithful a correspondence there is between a mental construct and the part of the world-as-it-is that it represents, but what it is that the mental construct can do, what function it fulfils for its possessor. The answer is obvious: the construct enables its possessor to adapt to and survive in its environment. There are two parts to this, evolutionary adaptation and learning, including perception. In evolution, natural selection is made from biological variations by the survival of the gene line determining the selected variation. There is no question here of the evolutionary adaptation resembling

---

[98] Franz Brentano, *Psychology from an Empirical Standpoint*, pp. 88-89 (of original work)

[99] Kasimir Twardowski, *On the Content and Object of Presentations*, p. 1 (of original work)

[100] Karl H. Pribram, *Languages of the Brain*, chap. 8

[101] Gerald Edelman, *Bright Air, Brilliant Fire*, p. 81

its environment.

Now consider learning, that is, the making of mental constructs or representations of the environment, and perceiving the environment accordingly. Again there is no question of a representation resembling the environment in order to enable its possessor to survive. What the possessor of the representation is doing is constructing a model by which to adapt to and anticipate environmental change. This view agrees with that of the neuroscientist, J.Z. Young:

> When an animal learns, it gradually comes to take actions that are appropriate to certain aspects of the situations it has experienced. Only in this sense can it be said to 'represent' these situations.[102]

That representations do not 'represent' the environment in the sense of resembling it is also argued by Kathleen Akins[103], who concludes that philosophical concerns about "aboutness" are misconceived, as "aboutness" is not about anything in the ordinary sense of the word 'about'. The vision of the world before your eyes, or at least the neurological basis of it, is just a construct enabling you to successfully navigate your way about it. That the world may appear different to different eyes, or from different perspectives of knowledge and intent, confirms this. An organism is constrained by its environment in respect of its basic functions, namely supply of nutrients, growth and procreation. Adaptation amounts to the internalization of response patterns so as to exploit the environment in the carrying out of the basic functions and minimize the unwanted impact of environmental constraint on those functions. Such internalization of response patterns may reflect quite complex forms of adaptation, the level of complexity depending on the complexity of the environment within which an organism lives. An organism that possesses locomotive ability requires a significantly higher order of complexity of adaptation (with a corresponding complexity of structure) than one that remains in a fixed location, particularly for the location of its own body in relation to its environment, and also for the greater complexity of environment that locomotion opens up. It is apparently the organism possessing locomotion that can be characterized by the possession of a central nervous system. An instructive example of this is the tunicate (sea squirt), first studied by the Emperor Hirohito. As a larva capable of locomotion, the sea squirt possesses

> a brain-like ganglion which can be informed about the environment by peripheral sensory input from a statocyst (organ for balance), a primitive eye, and a notocord (primitive spinal chord). These central nervous structures

---

[102] J.Z. Young, *A Model of the Brain*, p. 28

[103] Kathleen Akins, "Of Sensory Systems and the 'Aboutness' of Mental States", pp. 369-394

> have the connections necessary to deal with the continuously changing environment, as this primitive tadpole-like larva swims through the water.[104]

When mature the tunicate attaches itself permanently to a rock, and no longer needing most of its brain, consumes it ("a process paralleled by some human academics upon obtaining university tenure").

> The lesson of this evolutionary stage is, of course, very clear. It is that brains are needed only in those multicellular beings that move actively.[105]

In order to complete the picture, we should consider how a mental construct or representation may be brought into existence to fulfil its function of enabling its possessor to survive: how does an organism respond constructively to sensory impingements from its environment? We are asking here what the neurophysiological process might be.

It is of course possible, and is psychologically plausible (though we have ruled it out above), that somehow, over time, sensory impingements create or mould within the observer an image or impression of the environment, or of the parts of it that are relevant to his well-being. This was, in fact, the kind of process that was initially proposed to explain the operation of the immune system, and is an instructive example to consider. The immune system is described by Edelman as follows:

> If I inject a protein into an individual's body that does not resemble its own proteins, specialized cells called lymphocytes respond by producing molecules called antibodies. These molecules bind by fitting to specific and characteristic portions of the foreign molecule, or antigen, as it is called. A second and later encounter allows these antibodies to bind even more effectively to just those antigens. Perhaps more astonishing is the fact that a specific recognition event occurs even for new molecules synthesized by organic chemists, molecules that [had] never existed before either in the responding species or in the history of the earth for that matter.
>
> How can an individual's body positively distinguish novel molecules in such a specific fashion?[106]

The initial theory proposed to account for this was called the theory of instruction: the immune system was instructed by the antigen as to how it might defeat it—very obliging of the antigen indeed. The theory went like this:

> . . . in the immune system, a foreign molecule transferred information about its shape and structure to the combining site of the antibody molecule. It then removed itself (the way a cookie cutter would be removed from dough) leaving a crevice of complementary shape that could then bind to all foreign molecules with regions having the shape with which the impression was

[104] Llinás, *op. cit.*, p. 341

[105] Llinás, *op. cit.*, pp. 341-343

[106] Edelman, *op. cit.*, p. 75

originally made.[107]

This theory is at least more credible than one whereby a faithful image of a whole environment may be constructed within an organism in all its complexity. Its credibility is weakened, however, by the assumed cooperation of the antigen in its own destruction—surely antigens would have evolved that do not cooperate in the way supposed. One can speculate; but one can also test, and under test the theory of instruction has been shown to be false. It will be remembered that a similar false theory of direct environmental influence was once proposed to account for evolution, Lamarck's theory of acquired characteristics. The accepted theory for the immune system is the theory of clonal selection, due to Frank MacFarlane Burnet, and is, like Darwin's theory of evolution, based on the idea of selection. Edelman describes it thus:

> Burnet maintained that, prior to a confrontation with any foreign molecule, an individual's body has the ability to make a huge repertoire of antibody molecules, each with a different shape at its binding site. When a foreign molecule (say on a virus or bacterium) is introduced into the body, it encounters a *population* of cells, each with a *different* antibody on its surface. It binds to those cells in the repertoire having antibodies whose combining sites happen to be more or less complementary to it. When a portion of an antigen binds to an antibody with a sufficiently close fit, it stimulates the cell (called a lymphocyte) bearing that antibody to divide repeatedly. This results in many more "progeny" cells having antibodies of the same shape and binding specificity.
>
> A group of daughter cells is called a clone (the asexual progeny of a single cell) and the whole process is one of differential reproduction by clonal selection.[108]

Now let us return to consideration of the process by which a representation is created. In each of the cases of evolution and the immune system it was seen that the cooperation of nature cannot be assumed in establishing the integrity of the individual organism—nature knows nothing of the rights of the individual. Likewise it cannot be assumed that nature will cooperate the construction of mental representations: these must at base level be physically determined by the individual's confrontation with nature. What we can more reasonably assume is that the individual has evolved with a sufficient wealth of potential models, namely cerebral connections, from which selection may be made to achieve adaptation to his environment, in a similar way to selection in evolution and immunity. This does not rule out construction except at the basic level, for a representation would normally be constituted by many selected connections from which it could be said to be constructed. Such a selective mechanism for learning was put forward by J.Z. Young:

---

[107] Edelman, *op. cit.*, p. 75

[108] Edelman, *op. cit.*, p. 77

> The thesis I wish to propound is that learning in the nervous system is similarly a selection among a previously available set of possible alternatives.[109]

This is likewise the mechanism proposed by Edelman (without reference to J.Z. Young) in his theory of neural Darwinism (theory of neuronal group selection), referred to earlier. While decisive confirmation still awaits such theories of selection, it is likely that a selective mechanism will play a significant role in the construction of mental representations.

An analogy with the development of science can be drawn. Science develops by selection from a repertoire of possible theories formulated in the 'cerebral connectionist' language of logic and mathematics. The repertoire is extended by developments in mathematics, as it is in evolution by mutation.

7. Idealism versus Realism

Summary: The duality of idealism and realism is dissolved by the relation of mind to world described in Section 6. The dissolution is achieved by the external/internal distinctions described there, and as also put forward by Carnap and Putnam. Similarity of observation between individuals, producing public observation, depends on biological and cultural similarity, the criterion for similarity of observation being behavioural, that is, intersubjective agreement. Some additional remarks on realism follow.

The description given above of observing-state and object may prompt the philosophically minded to respond that as the description makes the object a construct (or part thereof) of the mind, an idealistic view of the world is being proposed. The best way to answer this is to make quite clear what the proposal is and let the philosopher decide whether it falls within some kind of idealism.

First, the description is intended to be factual. It is a fact that our contact with the world is solely by sensory stimulation, and that this is converted into a rich and detailed representation, which is the world as we know it. A philosophical realist would say that the representation corresponds to the world as it is, more or less, while an idealist would say that the representation is an invention of the mind. (The word 'representation' is not intended to convey either view; the less familiar term 'construct' would carry the same meaning.) Given the facts of the matter, there can be no evidence either way, because there is no way of contacting the world as it is except by sensory stimulation and the ensuing representational constructions.[110] It is not surprising, then, that the realism–idealism polarity has been a perennial feature of philosophi-

---

[109] J.Z. Young, *op. cit.*, p. 30

[110] To clarify this point, consider the following allegory. *A* shows *B* a picture of an object *O*. *B* asks *A* to show him *O*. *A* responds by showing *B* another, more detailed, picture of *O*. *B* says, "No, that is not what I asked to see; I asked to see *O* itself." *A* says, "All I can show you are more detailed pictures of *O*, for *O* is something that can be seen only in pictures."

cal debate, for there is no way of deciding it—in truth there is nothing to decide.

Second, it would be misrepresenting the description to say that it makes the world a construct of the mind. The world is not constructed by the mind, but given to the mind via sensory stimulation. The mind's role is to produce a structure that will enable the individual to comprehend and survive in the world.

Third, it is the mental construct by which the world is known that produces its sense of reality for the individual observer. We are all realists when in our observing-states. And to check on the reality of something observed we adopt the method described in the previous section.

We conclude that the philosophical polarity of realism–idealism is misconceived. Reality has sense only in the context of a construct by which the world is represented. Carnap has given clear expression to this point of view in a linguistic framework, which we may take as standing for publicly shared mental constructs (of which more below):

> Let us consider as an example the simplest kind of entities dealt with in the everyday language: the spatio-temporally ordered system of observable things and events. Once we have accepted the thing language with its framework for things, we can raise and answer internal questions; e.g., "Is there a white piece of paper on my desk? . . . These questions are to be answered by empirical investigations. . . . The concept of reality occurring in these internal questions is an empirical, scientific, non-metaphysical concept. To recognize something as a real thing or event means to succeed in incorporating it into the system of things at a particular space-time position so that it fits together with the other things recognized as real, according to the rules of the framework.
>
> From these questions we must distinguish the external question of the reality of the thing world itself. In contrast to the former questions, this question is raised neither by the man in the street nor by scientists, but only by philosophers. Realists give an affirmative answer, subjective idealists a negative one, and the controversy goes on for centuries without ever being solved. And it cannot be solved because it is framed in a wrong way. To be real in the scientific sense means to be an element of the system; hence this concept cannot be meaningfully applied to the system itself.[111]

A similar expression of this thesis, in more naturalistic terms, is given by Putnam, in which he contrasts two philosophical perspectives:

> One of these perspectives is the perspective of metaphysical realism. On this perspective, the world consists of some fixed totality of mind-independent objects. There is exactly one true and complete description of 'the way the world is'. Truth involves some sort of correspondence relation between words or thought-signs and external things and sets of things. I

[111] Rudolf Carnap, "Empiricism, Semantics, and Ontology", pp. 242-243

> shall call this perspective the *externalist* perspective, because its favourite point of view is a God's Eye point of view.
>
> The perspective I shall defend has no unambiguous name. It is a late arrival in the history of philosophy, and even today it keeps being confused with other points of view of a quite different sort. I shall refer to it as the *internalist* perspective, because it is characteristic of this view to hold that *what objects does the world consist of?* is a question that it only makes sense to ask *within* a theory or description. Many 'internalist' philosophers, though not all, hold further that there is more than one 'true' theory or description of the world. 'Truth', in an internalist view, is some sort of (idealized) rational acceptability—some sort of ideal coherence of our beliefs with each other and with our experiences *as those experiences are themselves represented in our belief system*—and not correspondence with mind-independent or discourse-independent 'states of affairs'. There is no God's Eye point of view that we can know or usefully imagine; there are only the various points of view of actual persons reflecting various interests and purposes that their descriptions and theories subserve. ('Coherence theory of truth'; 'Non-realism'; 'Verificationism'; 'Pluralism'; 'Pragmatism'; are all terms that have been applied to the internalist perspective; but every one of these terms has connotations that are unacceptable because of their other historic applications.)[112]

Both of these quotations are philosophical rather than scientific in their reference.

A realist may be inclined to identify the positions taken by Carnap and Putnam with some kinds of idealism. It is true that they are not realist in the following sense defined by Keith Campbell:

> Realists in the philosophy of science are those philosophers who will not conclude, from the fact that scientific theories are undoubtedly constructs of human mentality and culture, that therefore the *content* of these theories is inevitably some function of the human mentality and culture that have produced them.[113]

They are not realists in this sense because (a) the content of a theory (or the object of a construct) can be referred to only be means of a theory (or construct), though generally, for well established (real) content, by more than one theory, and (b) the content of a theory generally includes other theory, which, if well established, may be taken as fact. In this respect Putnam contrasts himself with Rorty (and I contrast myself similarly). Discussing "Rorty's Short Way with the Question" of realism, Putnam writes that Rorty's

> argument is supposed to show that the whole idea that our words and thoughts sometimes do and sometimes do not "agree with" or "correspond to" or "represent" a reality outside themselves ought to be rejected as entirely empty. The reason given is that it is impossible to "stand outside" and

---

[112] Hilary Putnam, *Reason, Truth and History*, pp. 49-50

[113] Keith Campbell, "Selective Realism in the Philosophy of Physics", p. 27

> compare our thought and language with the world. The only access we have to the world is to the world as it is represented in thought and language. Rorty concludes that speaking of some of our words and thoughts as "true" or as "in agreement with the facts" is only "a compliment" that we pay to our own intellectual creations (the ones that help us "cope").
>
> If the question of realism could be disposed of so simply, then many other philosophical issues which are entangled with it could be disposed of as well. I agree with Rorty that we have no access to "unconceptualized reality". As John McDowell likes to put it, you can't view your language "from sideways on" in the way that the idea of looking at one's language and the world and comparing the two suggests. But it doesn't follow that language and thought do not describe something outside themselves, even if that something can only be described by describing it (that is by employing language and thought); and, as Rorty ought to have seen, the belief that they do plays an essential role *within* language and thought themselves and, more importantly, within our lives.[114]

Hence Putnam's term, "internal realism".

The reason it is difficult to conceive of objects as constructs is that we cannot observe the world except by means of constructs, and therefore find it difficult to stand outside a system of constructs in order to describe them. Suppose we observe a person, *O*, in an observing-state of observing a tree. If we ourselves also are observing the tree, how can we say that the tree is a construct of *O*? A tree, after all, is a tree, it is not a construct of someone's mind (in derogatory terms, a figment of the imagination), it is not even the object of a construct. On analyzing our perception of the tree, we could allow that the perception occurs by means of a representation of it in our mind; likewise a representation of it in *O*'s mind. (Berkeley would have it that we perceive the representation itself, but that is clearly wrong—we perceive the tree, the object of the representation, by means of the representation.) But is there not a real tree that is the object of both representations? Of course there is a real tree. But that does not oppose the fact that the real tree is an object of our mental construct, or the common object (in a sense explained below) of mental constructs of ourselves and *O*. The reason that there appears to be an opposition between real and construct is that there are here two different modes of description being used: the tree is real when described using the mental construct by which it is represented, that is, from the point of view of the observing-state; the tree is a mental construct of *O* when we are conceiving of the processes of *O*'s observing of the tree, that is, when we are describing an observing-state. The first mode of description is the one we naturally use in everyday life, for informal scientific description, and for most philosophical discussion. When Llinás writes that "we forget to tell our students that seeing

[114] Hilary Putnam, "The Question of Realism", p. 297

is *reconstructing* the external world", he is, by implication, using both modes of description: he is describing seeing the world as a constructive process ("perception is a dream modulated by sensory input"), but in calling a construct a 'reconstruction' he is taking the world as given. Errol Harris noted this practice:

> . . . I have argued that physiological theories, treating sense processes as the transmission of coded information, lead to self-refuting epistemological theories of perception, which are not themselves entailed by the physiological evidence, but to which physiologists are sometimes led by the tacit adoption of epistemological presuppositions. Philosophers, on the other hand, tend to be misled, by a superficial acquaintance with certain physiological facts, into too ready an acceptance of theories of the sense-data variety.[115]

When there is not a common object of perception, however, when *O* observes a tree where we observe a pole, it is necessary to distinguish more carefully between the two modes of description. If our object of observation is confirmed by further observation, then the need to describe *O*'s object as a mental construct is obvious. One is reminded here of Wittgenstein's duck–rabbit[116] (and numerous other ambiguous pictures), a drawing which can be seen to portray alternately a duck's head and a rabbit's head (but never both at once), thus demonstrating the pivotal role of mental construct in perception. Another example of mental construction is given by a figure due to Kanizsa[117]:

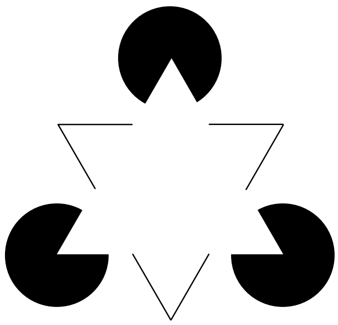


FIGURE 5

Here one sees a white triangle overlaying disks and lines which exists solely by virtue of those objects, for which, it has been confirmed, there exists a distinct neural correlate.

While observation depends on the individual mind, it is not made in isolation: of other observation; of affective, cognitive and conative aspects of our minds; or of the observations of others and hence of commonly accepted and socially sanctioned identifications. Elementary observation of natural phenomena is largely independent of the existence of culture, and is present, of course, in animals without culture. The influence of culture is important in establishing common mental constructs. Commonality of mental construct

---

[115] Errol Harris, *Hypothesis and Perception*, p. 240

[116] Ludwig Wittgenstein, *Philosophical Investigations*, p. 194

[117] G. Kanizsa, "Quasiperceptual Margins in Homogeneously Stimulated Fields", p. 48

depends on similarity, though certainly not identity, in biological, and in particular neurological, makeup, in social organization and in culture. Commonality of elementary observation of natural phenomena requires only similarity in biological makeup. The criterion of commonality of mental construct is behavioural effect, including linguistic behaviour, and is thus intersubjective in nature. The only criterion upon which, for example, similarity in perception of a tree or a colour can at present be judged is behaviour ensuing on the perception, as this is the only objective criterion that exists in the present state of knowledge. With sufficient knowledge of the neurological correlates of subjective experience, it might be possible to use neurological criteria to decide on commonality of mental construct, but for this to be independent of behavioural criteria, significant theoretical development in the neurological/behavioural area would be required, which at present would seem to lie far in the future.

The above theory of the concurrence of the mind and the world has been put forward as an interpretation that takes account of known facts, including the physiology and psychology of perception. It will be seen below that it also provides a natural elucidation of the seemingly intractable problem of conscious experience, and yields a parallel interpretation in the description of the relation of theory to observation in science. The theory is proposed as scientific, in the sense that it takes account of observed facts and can be developed into predictive scientific theory. Perhaps it should therefore be described as a guiding or organizing principle rather than a theory. As such it cannot be claimed to be without precedent, for it resonates the ideas of Kant and the subjective idealists that followed him, and also those of the phenomenalists. Mach, for instance, said that “the world consists only of our sensations”, objects are made up of elements which can be detected by the senses. Despite similarities, that is not the view put forward here, which is that the world, whatever it might be (and physics is the basic source for that), is communicated to us only through our senses, but what it is is what we make of it by our own constructions in response to sensory stimulations according to our own natural endowment and existing knowledge. These constructions, the knowledge we obtain by our learning from birth, are obtained by the same kind of iterative process that was described for the development of science in Section 5. Mach’s statement about the world is metaphysical—it is difficult, if not impossible, to know what difference it would make, whether true or false, to anything we might observe or how we might observe it. The proposals made here *do* make a difference to what we observe, and they *do not* depend on what we cannot observe.

Some remarks follow on everyday realism, scientific realism and metaphysical realism.

Everyday realism. It is usually assumed when conceiving of a situation that entities (objects or events) continue to exist when they are not directly perceived or sensed. This is seldom an explicit assumption, of course, but is implicit in our mental processes, particularly visual. The assumption concerns perception rather than observation in its general sense, as the latter includes the inferring of existence where there is no direct perception. A more general statement of existence would therefore be that entities are taken to exist when they are the objects of a conception, a theory for example. This is much the view of W.V. Quine, who puts it in the linguistic form, "To ask what the *assuming* of an object consists in is to ask what *referring* to the object consists in".[118] If the conception of which the entity is an object is well corroborated, then the entity is taken to possess everyday reality, to exist as conceived. This existence may be at a time far removed from the time when the conception is formed: thus dinosaurs exist in space–time, that is, they did exist, as they are objects of the science of palæontology.

Scientific realism. The structure of scientific realism is well displayed by the case of quantum theory. Quantum theory, understood as a formal system, concerns various entities that are conceived in mathematical terms. In terms of these entities and their relations, the theory, it is usually said, predicts certain observations. These observations are not of entities of the theory of course, but as with any scientific theory, correspond to the entities in a systematic way (by correspondence rules) which is not specified by the formal theory itself, but is given by a model for the theory. In one model for quantum theory it is said that particles, or at least their macroscopic effects, are observed, these particles being associated with mathematical entities of the theory.

Now if, as often happens (and certainly happens with less abstruse scientific theory), the model is carried beyond its immediate function and is identified with the theory itself, then it is concluded that the particles exist only when observed (in accordance with the correspondence rules)—they do not possess the reality of everyday objects. It must be recognized, however, that the quantum model that mentions particles is just a tool for connecting theory to observation, and the particles are fictitious objects of a statistical kind, somewhat as the average man with 2.6 children is a statistical fiction. It need not be a problem, therefore, that these fictitious objects exhibit behaviour that does not accord with what we would expect of a real object. Models for most scientific theories fall so naturally into our normal modes of thought that we are hardly aware of their existence as tools for application of theories. The

[118] W.V. Quine, "Things and Their Place in Theories", p. 2

case of quantum theory is different. Because quantum theory is probabilistic, there is no one model that will connect it to our everyday non-probabilistic observational experience, and the two principal models concerning particles and waves are not consistent with each other. This inconsistency, and the fact that scientists have no difficulty in applying the theory, demonstrates the fictitious nature of the models, and the unreality of the objects they speak of. In quantum theory scientific reality rests with the entities of the formal theory and everyday reality with observations they are associated with, the association being of a statistical nature.

Metaphysical realism. This is a philosophical extension of everyday realism. It assumes the existence of the world, by which may be meant everything in space–time (or in all places at all times), independently of the existence of any conception of it. Metaphysical reality thus accords with everyday reality in insisting that an unobserved entity can be real, but goes beyond it in not requiring reality to depend on the object's falling within any conception. Note that metaphysical realism does not mean just that the universe existed at a time when there was no conception of it, when there were no human beings for example. This meaning is included in everyday realism, as such an existence falls under our present conception (as explained under everyday realism).

Now if metaphysical realism is not just an alternative way of describing everyday realism, there must be something that is metaphysically real but not everyday real. In that case let the term 'meta-real' mean metaphysically real but not everyday real, so that meta-realism conforms to the statement, $(\exists U)(U$ does not fall under any concept), and any U that satisfies meta-realism is meta-real. We cannot say, of course, that U is the universe, because the universe falls within scientific cosmological conceptions. Now observe that meta-real, and hence metaphysically real, cannot be a concept, on pain of self contradiction: a U falling under the concept meta-real would not fall under any concept. Perhaps meta-real could be called a meta-concept. What is that? Perhaps it is a concept that only philosophers understand, and likewise metaphysical reality, just as God is a concept that only those of faith understand. As Wittgenstein wrote, "What we cannot speak about we must pass over in silence".[119] Unlike Wittgenstein himself, let us heed his advice.[120]

At the opposite pole to metaphysically real is metaphysically ideal, supported by the sceptical argument: for example, that we are no more than brains in a vat of nutrient which are wired up for the supply of all the sensory

[119] Ludwig Wittgenstein, *Tractatus Logico-Philosophicus*, p. 151

[120] "Mr. Wittgenstein manages to say a good deal about what cannot be said", Bertrand Russell, Introduction to Ludwig Wittgenstein, *Tractatus Logico-Philosophicus*, p. xxi

stimuli that provide the full range of our experiences; or, in Descartes's version, that these stimuli are supplied by an evil demon. Each of these metaphysical notions introduces an entity, so specified as to be beyond the range of our possible knowledge, that functions either to give support to the world as we conceive it by extending it or to undermine the world as we conceive it by diminishing it. In neither case would the full range of our experience differ by one iota whether the notion were true or false. These metaphysical notions are apparently introduced only as a substitute for knowledge of the full complexity of the conceptual world which we inhabit, roles once filled by God and the Devil.

8. Formal Analysis of Organism and Environment

Summary: A symbolic description of the relation between an organism and its environment is given showing the form of the representation of the environment in the organism and how intersubjective representation may come about.

In order to fix our ideas it is instructive to express them in formal terms. Let the state of the central nervous system at some initial time, which we may take to be 0, be denoted by $\mathbf{C}_0$. Between time 0 and time t (> 0) a pattern of environmental sensory stimuli impinges on the central nervous system. Denote this pattern by $\mathbf{E}_t$, which belongs to a set of possible environmental impingements E. Denote the state of the central nervous system at time t by $\mathbf{C}_t$. If we assume the system consisting of the central nervous system and its environmental impingements to be physically deterministic (as far as neural processes are concerned) and to be isolated from outside perturbation, then we can take $\mathbf{C}_t$ to be dependent on $\mathbf{C}_0$ and $\mathbf{E}_t$ alone, and write

$$\mathbf{C}_t = T(\mathbf{C}_0, \mathbf{E}_t),$$

where T summarizes the physical transformation processes that take a state $\mathbf{C}_0$ to a state $\mathbf{C}_t$ in the presence of environmental impingements $\mathbf{E}_t$. Let

$$E(\mathbf{C}_t|\mathbf{C}_0) =_{\mathrm{df}} \{\mathbf{E} : \mathbf{E} \in \mathrm{E} \;\&\; \mathbf{C}_t = T(\mathbf{C}_0, \mathbf{E})\}.$$

This is the set of all environmental impingements that give rise to $\mathbf{C}_t$, given $\mathbf{C}_0$. Note that $\mathbf{E}_t \in E(\mathbf{C}_t|\mathbf{C}_0)$, and that $E(\mathbf{C}_t|\mathbf{C}_0) = E(\mathbf{C}_t'|\mathbf{C}_0)$ if and only if $\mathbf{C}_t = \mathbf{C}_t'$. Any two $\mathbf{E}$'s lying in $E(\mathbf{C}_t|\mathbf{C}_0)$ are called equivalent under $\mathbf{C}_t|\mathbf{C}_0$. This equivalence induces a partitioning of the class of all environmental impingements E into the equivalence classes $E(\mathbf{C}_t|\mathbf{C}_0)$, which are in one-to-one correspondence with constructs $\mathbf{C}_t|\mathbf{C}_0$. Such a construct may be thought of as that part of $\mathbf{C}_t$ which reflects the influence of $\mathbf{E}_t$.

Now in a stable environment over a sufficiently long period of time (sufficiently large t) one might regard $E(\mathbf{C}_t|\mathbf{C}_0)$ as a fair sampling, particularly in the case of an organism actively exploring its environment, of environmental impingements that could arise from a common source $\mathbf{S}$, which we may call a state of affairs. Considerations such as this are no doubt what give plausibility to belief in the existence of such a state of affairs. This is an ergodic argument of the kind first used by Maxwell and Boltzmann to establish a correspondence between the micro-physical theory of the statistical mechanics of gases and the macro-physical theory of thermodynamics, that is to say, a reduction of the macro-physical by the micro-physical. In the situation we are considering, environmental impingements ($\mathbf{E}_t$) play the part of the micro-physical, and neural constructions ($\mathbf{C}_t|\mathbf{C}_0$, not the individual neurons) play the part of micro-physical constructions corresponding to macro-physical phenomena, $E(\mathbf{C}_t|\mathbf{C}_0)$ being a subspace of the phase space of the micro-physical, as in statistical mechanics. (An excellent account of the ergodic argument is given by Lawrence Sklar[121].)

The correspondence between statistical mechanics and thermodynamics first investigated by Maxwell and Boltzmann is called a reduction of thermodynamics by statistical mechanics. What the reduction comes to is the construction in statistical mechanical terms of a theory which can be shown to be isomorphic to thermodynamics; loosely speaking, the construction of thermodynamics within statistical mechanics. (The classical account of theory reduction was introduced by Ernest Nagel[122], and has been given an extensive revision by C.A. Hooker[123]; see also P.M. Churchland[124] and P.S. Churchland[125].)

In the analogous case of the central nervous system, neural construction is here being characterized as a reduction: $\mathbf{C}_t|\mathbf{C}_0$ is a construction from environmental stimuli isomorphic to a state of affairs **S**. Thus the role of **S** given by the ergodic argument is as the state of affairs given in terms of its reduction by an organism's central nervous system. In this case correspondence is not between theories conceived in formal terms, but between modes of description, on the one hand description in neurological terms, on the other hand description in terms employed for the conscious life of an organism. This may be thought of as akin to the reduction of psychology by neurology.

Let us turn to the question of the existence of the state of affairs, **S**. The sense in which a state of affairs can be said to have an existence as a real entity requires careful formulation. Notice that **S** was postulated in the context of the above ergodic/reductive argument, which was conducted from the perspective of an observer of an organism, not from the perspective of an organism itself. The latter perspective, that of an actor on the stage rather than a member of

---

[121] Lawrence Sklar, *Physics and Chance*

[122] Ernest Nagel, *The Structure of Science,* ch. 11

[123] C.A. Hooker, "Towards a General Theory of Reduction", in *Dialogue,* vol. 20

[124] P.M. Churchland, *Scientific Realism and the Plasticity of Mind*

[125] P.S. Churchland, *Neurophilosophy*

the audience, does not lead to a state of affairs **S** independent of the structure $\mathbf{C}_t|\mathbf{C}_0$, for no such state of affairs can be derived from of the processes associated with an organism. The formal analysis given above leads to the construction $\mathbf{C}_t|\mathbf{C}_0$ and the corresponding class of environmental stimuli $E(\mathbf{C}_t|\mathbf{C}_0)$, and it is from within the construction $\mathbf{C}_t|\mathbf{C}_0$ alone that the organism comprehends and acts within its environment. As the terms in which it comprehends its environment are those given by the content of $\mathbf{C}_t|\mathbf{C}_0$, the content may be identified with the state of affairs **S**. Thus the content of $\mathbf{C}_t|\mathbf{C}_0$ is isomorphic to $\mathbf{C}_t|\mathbf{C}_0$; the construct and its content have the same form, but are comprehended from different points of view. How can these two points of view be distinguished? They are respectively like the points of view of one who uses a tool and one who describes it. In using a tool, the tool becomes part of one's conscious being; but this is not so with describing it. If consciousness is what it is to be an organism, then it is what it is to be an organism using the tools which constitute it. (Refer to Part II, Section 12 for consciousness.)

It might be replied that if an assumption about the existence of a state of affairs **S** independent of the organism needs to be made in describing the organism, then **S** must necessarily have an independent existence. But as such an assumption must belong to the observer of the organism by virtue of a construct of the observer's own central nervous system, this reply does no more to establish the independent existence of **S** than the organism's construct does. There is no point of reference beyond the neural constructs of organisms which can be used to establish the independent existence of states of affairs independent of any organism, for we are all organisms—we cannot escape our human condition.

Now consider briefly the establishment of intersubjective, and thus public, constructs by means of communication between organisms of similar conceptual endowment. In an idealized situation, O and O' are two identical organisms living in the same environment. Let their identical neural constructs be denoted by $\mathbf{C}_0$. Living in the same environment, their environmental impingements are partitioned identically. Suppose that O and O' both experience a perception, and let the associated environmental impingements be $\mathbf{E}_t$ and $\mathbf{E}_t'$ respectively. Now suppose that $\mathbf{E}_t$ and $\mathbf{E}_t'$ lie in the same equivalence class of environmental impingements, which we may denote by $E(\mathbf{C}_t|\mathbf{C}_0)$, with $\mathbf{C}_t = T(\mathbf{C}_0, \mathbf{E}_t) = T(\mathbf{C}_0, \mathbf{E}_t')$, a neural construct common to both O and O'.

The possibility of equivalence of $\mathbf{E}_t$ and $\mathbf{E}_t'$, and common neural construct $\mathbf{C}_t$, opens the way to communication between O and O', if they are equipped for it. This can be done by the association of convenient, standardized equivalence classes of impingements with other equivalence classes of impingements: in terms of content, it is the associating of symbols with entities symbolized. By this means, organism O may refer organism O' to part of the content of $\mathbf{C}_t$ by means of such a symbol.

This is a bare sketch of idealized communication. Relaxing the ideal conditions would not be expected to invalidate the process, but yield a realization departing from the ideal.

9. Comparison with Other Work

Summary: The present thesis is compared with four other theses.
(i) Velmans's reflexive model of experience. Here a neural representation "reflexively projects" events and objects to locations as represented, so that they are experienced as being at those locations. Such experience is phenomenal consciousness, which cannot be said to have an unambiguous location.
(ii) Recapitulation of the present thesis. A summary is given for comparison with the other theses considered.
(iii) Popper's three worlds. The worlds are the physical, the mental, and the objective world of ideas, and their unity encompasses all things. In this unity the mental world is the causal mediator between the other two worlds, the causal processes being sense perception and biological interaction. There is a want of clarity in this thesis.
(iv) Bolzano's semantic structure. Bolzano applied to the mind–world relationship the methods he used to give mathematics a proper logical structure. The resulting structure is consistent but not clearly related to natural processes.
(v) Brentano's thesis. Brentano introduced intentionality in the modern sense, whereby every mental state contains its reference to the world within it. The relation between a real object and an intentional object is a difficulty for which a solution is proposed.
(vi) Comparison with previous accounts of the mind–world relationship. A table of comparative accounts is presented.

(i) Velmans's reflexive model of experience

A psychologist who has put forward a proposal that has some similarity to the proposal put forward here is Max Velmans. The aim of his proposal, which he calls a reflexive model of consciousness, is to explain conscious experience. It is of value to consider Velmans's proposal because it was presented at a symposium where comments were made and recorded, displaying some confusion surrounding this matter. Velmans describes his proposal as follows:

> Thus, the reflexive model makes the conventional assumptions that representations of external events are formed within the subject's brain and that under appropriate conditions these are accompanied by experiences of the represented events. Unconventionally, it also suggests that the brain models the world by *reflexively projecting* experiences to the judged location of the events they represent. On this view, the world as experienced (the phenomenal world) is a representation, formed by sense organs and perceptual processes that have developed in the course of human evolution. Being *part of* consciousness, the phenomenal world cannot be thought of as *sepa-*

rate from consciousness.[126]

Velmans notes, however, that “if the phenomenal world is just a representation, it cannot be the ‘thing-itself’”, an entity that he apparently takes from Kant.

Velmans produces Figure 6 in illustration of reflexive projection. The figure shows the object, a cat, as-perceived by both the subject, who holds a representation of it, and an observer, who also observes the subject. Thus subjective experience of the object becomes also inter-subjective—the object is publicly perceived—so that the subjective experience becomes amenable to scientific study, in particular psychological. Velmans contrasts his proposal with both a dualist model and a reductionist model, in both of which the experience of the object is held to take place in the subject’s mind, a view that he believes hinders our understanding of representation, consciousness and so on.

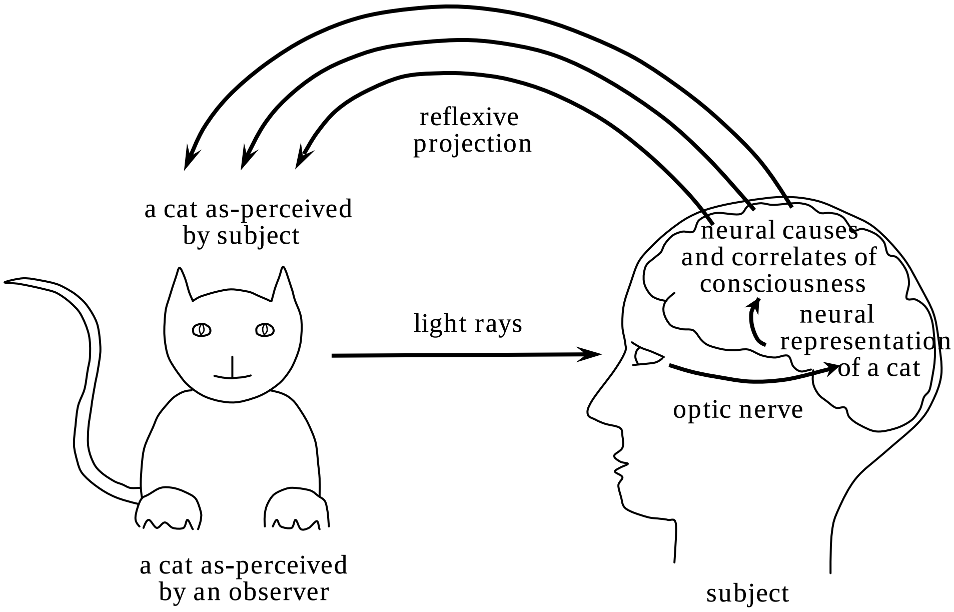


FIGURE 6: REFLEXIVE MODEL OF VISUAL PERCEPTION (FROM VELMANS)

The figure is drawn from an inter-subjective, or public, point of view, which means that it depicts what anyone observing or analysing the situation would see or conjecture. The cat that is shown is therefore what would be seen by anyone, including the subject and the observer. It should not be interpreted, however, as showing the subject’s representation as deriving from his own reflexive projection.

Velmans’s proposal may be summarized as follows:

126 Max Velmans, “A reflexive science of consciousness”, p. 84

1. There are neural representations of the external world.
2. Corresponding to neural representations there may be experiences of the external world.
3. The external world as experienced is called the phenomenal world.
4. Events of the phenomenal world are 'reflexively projected' to their assumed locations. That is, their locations are not just recorded in their representations, but are experienced as being at their locations.
5. The phenomenal world is part of consciousness.

Velmans offers in illustration of this model the phenomenon of virtual reality,
where a person is brought to observe as real a situation which is entirely contrived by simulation of the sensory input that the real situation would produce:

> I own a fine hologram of the head of Sulis Minerva, a goddess of the waters in the old Roman city of Bath. If the hologram is mounted in a box and one is not told that it is a hologram, it looks (from the front) just like the statue of a head in a box. But what one sees is just a three-dimensional *image* of a head in a box. In the reflexive model, this is again easily explained. The pattern of light reflected from the two-dimensional surface of the hologram resembles the pattern of light that would be reflected from a three-dimensional head located in the box. Accordingly, perceptual processes construe the reflecting surface to *be* a three-dimensional head and reflexively project an image of a head to its judged location, in the box. The image of a head out in space is the only image one experiences (there is no additional image of a head experienced to be in one's mind or brain). If the hologram were replaced by an actual head, perceptual processing would be the same.[127]

This shows that the object of a representation inheres in the representation itself and is given its sense of reality by it. Unfortunately, this inclines Velmans to think of the experiential object as being located with the experience, and therefore mental experience itself as being reflexively projected, though he equivocates about this, as is seen in the exchange below. It is certainly not necessary to think of it this way, for experience of the external world and the external world as experienced are formally different categories, the former being a representation of the latter.

Benjamin Libet, well-known for neurological experiments demonstrating that willed actions may be initiated prior to consciousness of the willing, was present at the symposium and summarized Velmans's idea of reflexive projection in the following succinct terms:

> *Libet:* It seems to me that the reflexive model is simply a special case of what's going on all the time—subjective referral. If you stimulate the somatosensory cortex electrically, you don't feel anything in the brain or head at

[127] Velmans, *op. cit.*, p. 86

> all, you feel it out in your hand or wherever the representation is of that cortical site. That applies to all sensibilities. There is a referral away from the brain to the body parts; there is referral out into space, if the stimulus appears to be coming from there. The representations of the neuronal patterns of the brain are not isomorphic [mapped one-to-one while preserving form] with what's coming in[128], so there is referral not only at a distance, but also in terms of the shape or configuration of the image, which is not identical with the neuronal representation at all.[129]

It is, of course, of paramount importance to a living being for its survival and integrity that it locate the source of any phenomenal experience, and then associate the experience with that source. Where the source cannot be readily identified, the subject will continually try various plausible possibilities until it is satisfied. A single causal agent may produce more than one phenomenal experience. For example, a blinding light can produce an identification with the source of the light, and simultaneously a sensation identified with the eyes which alerts the subject to possible damage. I am subject to the experience of ringing in the ears, and can remember that when the experience first occurred I tried to identify it with various external events, such as work on nearby railway lines, a hypothesis that failed because the ringing persisted when I moved away from them. Eventually I learned that the ringing arose from a source within the ears themselves, caused by damage due to an influenza virus. Immediately the ringing became located within the ears, and soon receded into the unconscious, whence it reappears only occasionally when attention is drawn to it.

Thomas Nagel raised the question as to where a visual experience is located.

> *Nagel:* Max, it seems to me that you are introducing an unnecessary puzzle in asking where is the head when you look at a hologram of a head. The head is the intentional object of my perceptual experience—what it is a perception *of*. Of course, the object of my experience is located in the box, but my visual experience of seeing a head in the box is in my head. Are you denying that?
>
> *Velmans:* Yes. I would say that you are giving a characterization of your visual experience that misrepresents what you actually experience! You make a distinction between the intentional object of perceptual experience (the head as experienced), which you agree is out in the world, and your experience *of* a head, which you claim is in *your* head. But when you look at the hologram, you *don't* have an experience of the holographic head in your own head. The only visual experience you have is of a head in a box, out in the world.
>
> *Nagel:* I don't say that I *experience* the visual experience of the head as

---

[128] Llinás says there is a *homo*morphism from "what's coming in" to the representations; see above.

[129] Velmans, *op. cit.*, p. 94

> being in my head. I just say it is *in fact* an event taking place in my brain. If we want to locate the mental event in space, its location is in my head. There is absolutely no incompatibility between that and locating the intentional object of that perceptual experience outside my head. These are really two completely different levels of description of the thing.[130]

Three entities are being spoken about here: (a) a visual experience, more generally a mental experience; (b) what the visual experience is about or of, its object; (c) the neural state corresponding the visual experience, which may be called the neural representation. It is agreed that the object of a visual experience, the head of Sulis Minerva, is situated where it is subjectively referred in the box; and it is agreed that the neural representation is in the brain. What is not agreed is where, if anywhere, the visual experience is located, and how it relates to its object. That problem is brought into the open by John Searle.

> *Searle:* . . . sometimes when we experience that world, it impacts on our nervous system in such a way that the external independently existing world causes us to have in our heads conscious experiences of that world.
>
> *Velmans:* I would say that such experiences are not phenomenally 'in our heads'; they are phenomenally distributed out in the space surrounding our bodies. But, I agree with the basic point you are making that there really is a world (a thing-itself) that such experiences represent.
>
> *Searle:* There really is a world, it causes us to have experiences, those experiences are all in our heads, though of course they make reference to the world that is not in our heads.
>
> *Velmans:* But the world is not normally experienced to be inside our heads![131]

Surely Velmans is right in denying that conscious experiences are located in our heads. But is he right in saying that they are distributed in the vicinity of our bodies? Does conscious experience have a location? Aristotle thought sensation to be situated in the heart; which is reasonable, as raised emotion often produces a sensation there. Sensations certainly are located, in some sense, in the body. As conscious experiences are ours and generally include references to ourselves, they are usually felt to be located somewhere within ourselves. To say this is not to give a strictly physical location, however, but is more like saying that the having of a conscious experience is a state of the person, that is, saying that the person is in a conscious state. The simple answer is to say that conscious experience is in the mind. Saying this does not give a location, of course, as the mind itself does not have a location: the mind is a reification of the mental, concerning cognitive, conative and affective behaviour, or states, which are described in the mentalistic–psychological language used for our social thinking and intercourse. Provided one can keep

---

[130] Velmans, *op. cit.*, p. 92

[131] Velmans, *op. cit.*, p. 98

hold of the facts and convey them to others, it matters little how we express ourselves. But with mental matters the facts are complex, and thus it is important to understand the implications of our modes of expression.

(ii) Recapitulation of the present thesis

The thesis that has been put forward here is that as a result of sensory stimulation of an observer/actor *O* deriving from his environment, a mental construct is formed within the central nervous system of *O* which constitutes a representation of the environment in terms appropriate to his adaptation and survival. These terms include, amongst others, spatial terms, by which the locations and movement of objects and of *O* himself are determined. The reality of the content of the representation, and of its objects, is given by the fact that in *O*'s consciousness he is not a mere observer of the representation, observing, as it were, a picture of his environment in the Cartesian dualist manner, but he lives and acts within that representation, and is known to himself only in such a way: the representation is part of *O* himself and of the processes by which he lives, but his consciousness lies within the representation, so to speak, and therefore cannot encompass it as such. It is for this reason that introspection does not reveal the actual processes of observation and that these processes are difficult to conceive of. This subjective connection is the basis of the relation between mind and world. It is expanded through social intercourse, as indicated earlier (Section 8), into the intersubjective. Through the medium of language (in the case of humans) the intersubjective develops toward the objective, which may be equated to the cultural/scientific realm, by modifying the subjective in the iterative manner outlined in Section 3.

There are three ontological transitions that can be distinguished in the mind–world relation:

- T1 From neurological to psychological—subjective representation explained in terms of physical processes;
- T2 From psychological to sociological—intersubjective representation explained in terms of subjective representation;
- T3 From sociological to cultural/scientific—objective representation explained in terms of intersubjective representation.

'*A* explained in terms of *B*' means a theory of *A* reduced to a theory *B* in the sense given in Section 8. A full exposition of the mind–world connection requires a multidisciplinary study of man and his culture, including neuroscience, psychology, sociology, anthropology, . . . , in fact, every discipline that studies an aspect of man in relation to the world. It is a vast study, but it is a study that is taking place now in a piecemeal, but increasingly unified, fashion, and is also becoming increasingly subjected to the scientific disciplines. What is required in order to abstract an understanding of the mind–world relation from these multidisciplinary studies is their coordination by a consistent theory, of the kind that is outlined here.

Examination of the complete mind–world relationship has generally been recognized as an area specially suited to philosophical study. The relation T1 has been the most difficult to comprehend. It has formed the nucleus of philosophical controversy since the time of Socrates, and has only recently become amenable to scientific investigation. There is an aspect of T1 that is widely held to be, and to be such as to remain, beyond the methods of science to explain: this is the aspect variously called 'consciousness', 'subjective point of view', 'qualia', 'conscious experience', 'sensation'. This will be discussed in Section 12.

(iii) Popper's three worlds

Karl Popper has written about a subdivision of the world into three worlds:

> In this pluralistic philosophy the world consists of at least three ontologically distinct sub-worlds; or, as I shall say, there are three worlds: the first is the physical world or the world of physical states; the second is the mental world or the world of mental states; and the third is the world of intelligibles, or of *ideas in the objective sense*; it is the world of possible objects of thought: the world of theories in themselves, and their logical relations; of arguments in themselves; and of problem situations in themselves.[132]

There is not an exact parallel between Popper's three worlds and the categories considered here. A rough correspondence might be this:

World 1, physical	↔	physical processes
World 2, mental	↔	subjective representation
World 3, objects of thought	↔	intersubjective & objective representation

Popper writes that "one of the fundamental problems of this pluralistic philosophy concerns the relationship between these three 'worlds'"[133] and proposes world 2 as the causal mediator between world 1 and world 3. Under the heading "The Causal Relations Between the Three Worlds" he writes that

> . . . the human mind can see a physical body in the literal sense of 'see' in which the eyes participate in the process. It can also 'see' or 'grasp' an arithmetical or geometrical object; a number, or a geometrical figure. But although this sense 'see' or 'grasp' is used in a metaphorical way, it nevertheless denotes a real relationship between the mind and its intelligible object, the arithmetical or geometrical object; and the relationship is closely analogous to 'seeing' in the literal sense. Thus the mind may be linked with ob-

[132] Karl Popper, *Objective Knowledge*, p. 154

[133] Popper, *op. cit.*, p. 155

> jects of both the first world and the third world.[134]

If the words 'see' and 'grasp' are taken to imply something like 'form a representation of', then the causal connections of world 1 and world 3 are expressed through their representations in world 2. Popper offers no suggestion as to how representations may be thought of, that is, as to what sort of relationship 'seeing' is, or as to how representation in world 2 of world 1 and world 3 might transmit a causal connection. It is more to the point that world 1 and world 3 are *represented* as causally connected in world 2, and hence in world 3. Here, for example, is a representation in world 3 of the causal connection between climate and culture (world 1 and world 3) in Mesopotamia and Egypt (the reader uninterested in Mesopotamia and Egypt may omit this quotation).

> Although there was always the possibility of drought or flooding, the Nile seldom brought disaster to Egypt. Mesopotamian civilization developed in a very different environment. The Tigris and Euphrates are far less uniform in their behaviour than the Nile. The inhabitants of ancient Mesopotamia had to contend with variations of climate, scorching winds, torrential rains, and devastating floods over which they had little control. The mood of Mesopotamian civilization reflected this element of force and violence in nature which gave no grounds for believing that the ravages of time could be surmounted by a ritual cult like that of Osiris in Egypt. Although there was evidence of cosmic order in the motions of sun, moon, and stars and in the cycle of the seasons, this order was not regarded as securely established but had continually to be achieved by the integration of conflicting divine wills or powers. The basic framework of society in Mesopotamia remained the same for 2,000 years or more, but at different times Sumerians, Babylonians, and Assyrians were dominant and the order of society was far less static than in Egypt. Whereas in Egypt the pharaoh symbolized the triumph of an invincible divine order over the forces of chaos, in Mesopotamia kingship represented the struggle of a human order with all its anxieties and hazards to integrate itself with the universe.[135]

As apparently Popper is not thinking of the causal relations between his worlds in terms of representation, how are they established? Popper attributes his world 3 idea to Bolzano:

> . . . I had developed certain views of Bolzano's (and, as I later found, also of Frege's) into a theory of what I called the "third world" or "world 3". It was only then that it dawned on me that the body–mind problem could be completely transformed if we call the theory of world 3 to our aid. For it can help us to develop at least the rudiments of an *objective theory*—a biological theory—not only of subjective states of consciousness but also of selves.[136]

---

[134] Popper, *op. cit.*, p. 155

[135] G.J. Whitrow, *Time in History*, p. 29

[136] Karl Popper, *Unended Quest*, p. 222

This "biological theory" Popper uses to fashion the connecting links between his three worlds:

> So I propose, to start with, that we regard the human mind quite naively as if it were a highly developed bodily organ, and that we ask ourselves, as we might with respect to a sense organ, what it contributes to the household of the organism.
>
> To this question there is at hand a typical answer which I propose to dismiss. It is that our consciousness enables us to see, or perceive, things. I dismiss this answer because for such purposes we have eyes and other sense organs. . . .
>
> I propose instead that we regard the human mind first of all as *an organ that produces objects of the human world* 3 (in the more general sense) and interacts with them.[137]

In order to call the connections biological, Popper calls the mind a bodily organ (is this organ additional to the brain?), and claims that perception is achieved with the sense organs (does this exclude the mind from the perceptual process?). He also claims that world 3 objects can interact with a biological organ, the mind, for which interaction the 'inmates' of world 3 are 'real':

> . . . I have become a realist with respect to the world 3 of *problems, theories, and critical arguments.*
> . . . I arrived at the conclusion that its inmates were real; indeed, more or less as real as physical tables and chairs.[138]

The causal relations between Popper's worlds are thus explained in terms of sense perception and biological interaction. As the former is hardly irreducible and the latter hardly convincing, we shall proceed to the inspirational source of world 3.

(iv) Bolzano's semantic structure

Bolzano is described by Alberto Coffa as "the founder of the semantic tradition"[139], by which analysis of the factual content of the world was transformed, in reaction to the idealism stimulated by Kant, into analysis of statements about the world. According to Coffa,

> . . . the semantic tradition [was] a philosophical movement that, unlike positivism, took the a priori seriously and, unlike idealism, chose to look even more closely than Kant at his paradigm examples of the a priori.[140]

Prior to the establishment of a firm logical basis for the mathematics of continuity and limit by Bolzano, Cauchy, Weierstrass and others, these concepts had been thought of by mathematicians since the time of Newton in terms of

---

[137] Popper, *op. cit.*, p. 220-221

[138] Popper, *op. cit.*, p. 214

[139] J. Alberto Coffa, *The Semantic Tradition from Kant to Carnap*, p. 23

[140] Coffa, *op. cit.*, p. 23

the movement in space and time of idealized physical entities such as points (hence Kant's association of arithmetic with time); that is, mathematics was regarded as a physical idealization ('ideal' as in Plato), and so depended on physical intuition. It was this view of mathematics that was responsible for misleading Kant. What Bolzano did was to initiate the removal of physical intuition as a basis for mathematics (which is not to say that intuition did not continue to be of heuristic value). This turned out to be of enormous value in the subsequent development of mathematics.

Bolzano proceeded to extend the same logical/semantic methods to the problem of the mind–world relationship, another area of confusion bestowed on the philosophical world by Kant. While semantic methods are appropriate for an area of formal study, such as mathematics and logic, where facts do not have to be accommodated, they are sterile, and thus of only philosophical interest, when applied to empirical matters. (One hundred years after Bolzano, Russell proceeded similarly by extending his logicist methods in the foundations of mathematics to the empirical realm with his logical atomism—which is not to say that Russell regarded his ideas as empirical—and what new knowledge has that yielded? Here we need to distinguish between these philosophical methods and scientific model building by analogy, in say theoretical physics, which is certainly not sterile.) Bolzano treated the mind–world relationship formally in terms of mental representation. While this bestowed no benefit of a factual nature, it clarified logical distinctions. First, he distinguished between subjective and objective representations: subjective representations correspond to mental states, which are real; objective representations correspond to linguistic meanings, which are not real, and are the content of subjective representations. Second, he distinguished between an objective representation and its objects, which are real. This formal structure thus gives the connection between two so-called real entities, subjective representations and objects, the connection being that the content of a subjective representation refers to objects. It will be observed that the structure of Bolzano is built upon subjective representation: given subjective representation, objects follow. Bolzano's structure is expressed in semantic terms: 'meaning', 'content', 'representation' understood semantically, 'object of representation'. This enables one to talk about the mind–body relationship consistently, but provides no information as to what sort of processes are taking place. Furthermore, if those processes do not in fact fit into Bolzano's structure, then it can only be misleading for any scientific investigator who adopts it as a guide to his thinking.

(v) Brentano's thesis

While Bolzano looked ahead beyond Kant's idealism to linguistic philosophy, Brentano looked back from the prevailing subjective idealism to Aristotle for the source of his characterization of the mental in terms of intentionality. He wrote as quoted in Section 6:

> Every mental phenomenon is characterized by what the Scholastics of the Middle Ages called the intentional (or mental) inexistence of an object, and what we might call, though not wholly unambiguously, reference to a content, direction towards an object (which is not to be understood here as meaning a thing), or immanent objectivity. Every mental phenomenon includes something as object within itself, although they do not all do so in the same way. . . . We can therefore define mental phenomena by saying that they are those phenomena which contain an object intentionally within themselves.[141]

This proposal has been the source of much confusion, which no doubt derives to some extent from confusion in the mind of Brentano himself. What it appears to be expressing is the following:

(a) Every mental state *S* is associated with some object *O*;

(b) The nature of the association is that
  (i) *O* dwells within *S* in some sense,
  (ii) *S* incorporates direction towards *O*, and
  (iii) There is an act of presentation (representation) of *O* within *S*.

(c) Every mental state is at the same time directed reflexively towards itself.

There is a problem with Brentano's thesis which caused both himself and his followers a great deal of concern. The problem is, how does a mental state relate to the real world? Brentano was a realist, yet his idea of intentional inexistence can be interpreted only too easily in idealistic terms. Let us examine this with the aid of the summary given above. As to every *S* there is an *O*, *O* would appear to be dependent on, in fact to be part of, *S*, as the term 'intentional (in)existence' implies. As (a) necessitates that *O* exist as part of *S*, *O* cannot be an independent object which may or may not exist; and the status of *O*, as part of *S*, and hence of *S* itself, cannot vary according to whether or not *O* happens to correspond to an object external to *S*. Now consider the perception by means of *S* of an object *O′* which gives rise to *O*. How are *O* and *O′* related? By the above observations, they cannot be identical. The answer to this question must allow for, or explain, the existence of *O* when *O′* does not exist.

The following is offered as a solution consistent with Brentano's thesis. *S* incorporates within itself direction towards *O*: call this an *S*–direction towards *O*. It is assumed that as *O′* is perceived by means of a presentation of *O*, there is also in some sense a derived *S*–direction towards *O′*. (For example, if I see a real tree, then, besides being directed towards the percept of the tree, my

---

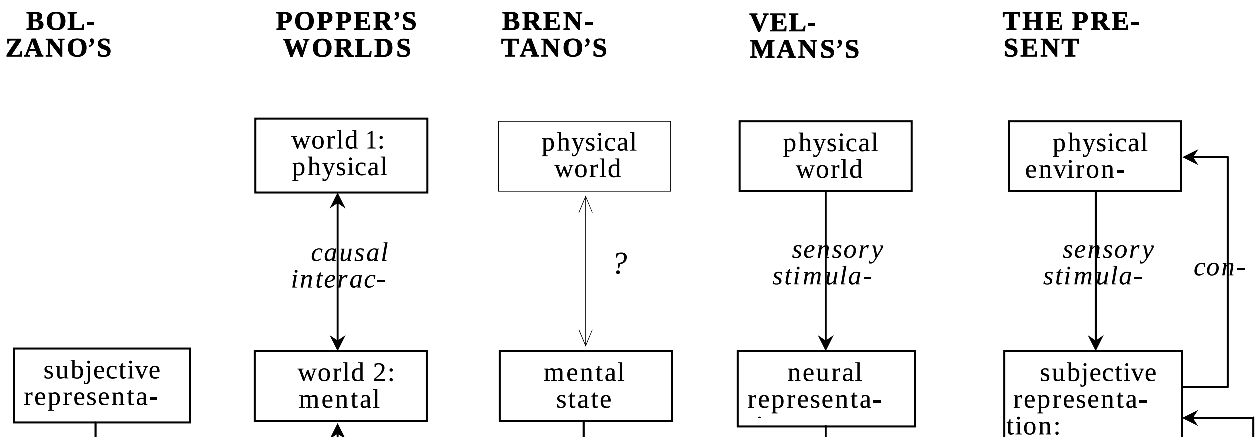
[141] Brentano, *Psychology from an Empirical Standpoint*, p. 88

mind, or at least its embodiment, is also directed in some sense towards the real tree.) As *O* and *O′* cannot be identical, *O′* being in the world external to *S*, the *S*–direction towards *O′* must be different from the *S*–direction towards *O*. Let *S′* be the physical correlate or embodiment of *S*. Then corresponding to, and by virtue of, the *S*–direction towards *O*, there is an *S′*–direction towards *O′*. (Consider by analogy the commander of a submarine tracking a ship by means of his submarine's periscope. The periscope (*S*) is directed towards the image (*O*) of the ship, while the submarine (*S′*) is directed towards the ship (*O′*), that is to say, directed in the sense of tracking it.) This proposal allows for the non-existence of *O′*, as *S′* would in that case be directed towards the *O′* assumed by virtue of the *S*–direction towards *O*.

Note that this is not part of the proposal of the present thesis, in which the principle of Occam's razor is honoured, for *O′* plays no part in the mind–world relationship apart from preserving an unexplained (naïve) realism: *O′* is unknown to *S* except through *O*, and is not necessary in order to account for *O*—postulation of *O′* is, in fact, *ad hoc*, for how can *O* be accounted for by something that is known only through it? But accounting for *S* and how *O* arises within *S* is another problem with Brentano's thesis. If there is an *O′*, then *O* must reflect *O′* in some fashion. How does *O* reflect *O′*? (We examined this problem earlier.) Perhaps, in evolutionary terms, just in this way, that the *S*–direction towards *O* produces the *S′*–direction towards *O′*, which is to the adaptive and survival advantage of *S′*. Again, postulation of *O′* is unnecessary for this purpose, as the presentation (construction) of *O* within *S* in response to sensory stimulation, whatever its source, is sufficient to fulfil this function.

(vi) Comparison with previous accounts of the mind–world relationship

Figure 7 gives a summary of the foregoing accounts of the mind–world relationship. In Brentano's account content and object are presented together in accordance with his view that direction towards an object is integral with the content. This is also a feature of Velmans's account and of the present thesis. Brentano (and also Velmans (see Section 9(i)) has been criticized for this on semantic grounds, as object and representation of object belong to different logical categories. However, unlike Bolzano's structure, these are not semantic constructions, so it should be permissible to have object and direction towards object incorporated in a single representation.



Note that in the proposal of the present thesis there are two alternative descriptions of subjective representations, physical and mental, according to the purpose of the description. Note also that subjective representation is shown as the pivotal process of the system, pivotal for a positive feedback loop (iteration), which is shown in two parts: stimulatory (the physical environment) and non-subjective representational (the social environment). This does not reduce the physical world to a subsidiary role, however, for the physical world, or perhaps more appropriately the universe of discourse, encompasses the entire system.

10. The Classification of Mental States

Summary: There are three mental domains, cognitive, conative and affective, all of which are present to some degree in any mental state or act. Affect is usually most effectively described using cognitive and conative terms, and perhaps for this reason is often ignored in phi-

> *losophical analysis. Pain includes a great variety of experience, dominated by the non-cognitive, though including the cognitive, all of which interact closely to produce the pain experience. Each of the kinds of mental state, sensation, perception and thought, can be described in terms of its cognitive, conative and affective content.*

The description of mental states in cognitive and non-cognitive terms has a long history:

> One of the very earliest models of the human personality, dating back to the ancient Greeks, involved the idea that the human psyche consisted of three basic domains: the **cognitive domain**, which is the thinking, reasoning part of the individual; the **conative domain**, which concerns the individual's will and intentions; and the **affective domain**, which is to do with feelings and emotions. One metaphor used to describe this was that of a charioteer driving two horses: the forces which provided the power to move the human spirit were the conative and affective domains, and the charioteer guiding them along was the cognitive domain.[142]

When discussing mental representation it is vision that we are often thinking of—it is taken as the exemplar. This is because vision is the dominant sense in man and because it permits of comparatively straightforward and unambiguous description and analysis, in cognitive terms at least, as against pain for example. But because vision can readily be idealized as the means by which we form an objective understanding of the world, with the senses as aids, the emphasis on vision tends to restrict our analysis to cognitive aspects of representation. And yet the non-cognitive aspects of representation, the affective and conative, constitute an important part of the consciousness that is created by representation. Without affect and conation, visual experience can become seemingly devoid of meaning, and lifeless. This becomes evident to us when, on occasion, our emotional contact with the world and consequently our will to live are diminished, as when a loved one, or love, is lost to us—

> A grief without a pang, void, dark, and drear,
> A stifled, drowsy, unimpassioned grief,
> Which finds no natural outlet, no relief,
> In word, or sigh, or tear –
> O Lady! in this wan and heartless mood,
> To other thoughts by yonder throstle woo'd,
> All this long eve, so balmy and serene,
> Have I been gazing on the western sky,
> And its peculiar tint of yellow green:
> And still I gaze – and with how blank an eye!
> And those thin clouds above, in flakes and bars,
> That give away their motion to the stars;
> Those stars, that glide behind them or between,
> Now sparkling, now bedimmed, but always seen:

---

[142] Nicky Hayes, *Foundations of Psychology*, p. 606

> Yon crescent Moon, as fixed as if it grew
> In its own cloudless, starless lake of blue;
> I see them all so excellently fair,
> I see, not feel, how beautiful they are! [143]

Here we witness cognition with reduced affect. This is mild in comparison with cognition that can occur with apparently complete removal of a normally associated affect, as with the Capgras Syndrome.

> When you see your father, your visual intelligence goes to work constructing the 3D shape of his face, the colour and texture of his skin, his expression, and ultimately his identity. Then, in the normal case, the constructions of your visual intelligence engage the resources of your emotional intelligence, and you have feelings appropriate to your father . . . In Capgras patients, however, the connection between visual intelligence and emotional intelligence is cut, so that the Capgras patient doesn't have appropriate feelings when he sees his father. Since the man in front of him looks like his father but doesn't feel like his father, the Capgras patient concludes, perhaps naturally enough, that the man must be an impostor. He certainly feels like an impostor. . . . It is not a problem of face recognition, or of vision more generally. Many Capgras patients . . . have normal vision and normal ability to discriminate and recognize faces.[144]

It can be surmised that affect must be present to some degree in any mental state that would usually be thought of as cognitive—pure cognition is merely an ideal.

When we turn to bodily sensations we find that they cannot be understood without taking account of both cognitive and non-cognitive aspects. As Newton demonstrated by means of a prism that white light can be separated into its component colours, so it can be shown that pain is composed of separate cognitive ("discriminative") and non-cognitive components.

> We can, either through purposeful intervention or accidents of Nature, dissociate our discriminative pain processing from our affective-motivational pain processing. Ingestion of morphine (or other opiates), lesions to the medial thalamus, and prefrontal lobotomies all result in sensations of pain without a sense of suffering and without producing characteristic pain behaviours (wincing, moaning, complaining, etc.). In these cases, patients can localize their pains but are not upset by the fact that they are in pain. We can also get reverse effects, to a degree. Fentanyl causes one to react in pain, yet inhibits our discriminatory abilities for the pain. Lesion studies and studies using hemispherectomies show that even with cortex completely missing, we can still have a pain sensation; we simply lack fine localization and intensity discrimination. Patients with Parkinson's disease and Huntington's disease often have pain sensations but are unable to indicate where they feel

---

[143] Samuel Taylor Coleridge, *Dejection: An Ode*

[144] Donald D. Hoffman, *Visual Intelligence, How We Create What We See*, pp. 201-202

pains.[145]

It is not only through drugs and surgery that the non-cognitive side of pain can be eliminated, but also through conditioning. Ronald Melzack

> . . . brought up a number of Scotch terriers from birth in sensory isolation, protecting them to such an extent that none of them ever felt a single scratch, knock, or blow. Pain simply did not exist for them.
>
> Later, when the dogs were grown up, they were abruptly exposed to brutal realities. When they bit each other in play, they seemed to feel as little pain as the boxer in the ring. They did not even flinch away or try to defend themselves, although wounds gradually formed and drew blood. To a burning candle they responded with curiosity and sniffed the flame. Of course they burned their muzzles badly. Even so, they did not learn their lesson, but kept on calmly sniffing any other open fire they saw. . . .
>
> The nervous systems of the Scotch terriers, however, was perfectly intact. They seemed to feel something, but could not make anything of it. . . . Strange as it sounds, even pain is a thing which to some extent has to be learnt.[146]

Compared to the cognitive, non-cognitive aspects of mental states are not so amenable to unambiguous description. This is because the cognitive, although of subjective origin, is amenable to the intersubjective processes, on which language depends, with subjects placed on an equal footing, while in the case of the non-cognitive intersubjective processes are decidedly one sided, with the balance weighed in favour of the subject. In the case of a pain with a clear cognitive component, a cut finger for example, the cognitive aspect is observable by all, while the affective aspect is experienced as a sensation by the subject, but can only be presumed from the behaviour of the subject and experienced empathetically by others. Because of this, descriptive terms for the non-cognitive tend often to be adapted from those employed for the cognitive. For example, one might speak of a stinging pain, one that would be experienced if one had been stung.

The spectrum of non-cognitive qualities of pain has been described and displayed on a scale of intensity by Melzack and Torgerson[147]. Their classification was obtained from the clinical literature under headings (dimensions) falling into sensory, affective and evaluative groupings. The classification reflects the views of those who experience pain and those who treat it. In the following list the qualities of pain are listed in order of intensity:

SENSORY

temporal	flickering, quivering, pulsing, throbbing, beating, pounding

[145] Valerie Hardcastle, “The Nature of Pain”, pp. 300-301

[146] Vitus B. Droscher, *The Magic of the Senses*, pp. 99-100, summarizing results reported in “Early Environment” by William R. Thompson and Ronald Melzack

[147] Ronald Melzack, *The Puzzle of Pain*, pp. 42-43, Figure 3

spatial	jumping, flashing, shooting
punctate pressure	pricking, boring, drilling, stabbing, lancinating
incisive pressure	sharp, cutting, lacerating
constrictive pressure	pinching, pressing, gnawing, cramping, crushing
traction pressure	tugging, pulling, wrenching
thermal	hot, burning, scalding, searing
brightness	tingling, itchy, smarting, stinging
dullness	dull, sore, hurting, aching, heavy
miscellaneous	tender, taut, rasping, splitting
AFFECTIVE	
tension	tiring, exhausting
autonomic	sickening, suffocating
fear	fearful, frightful, terrifying
punishment	punishing, gruelling, cruel, viscous, killing
EVALUATIVE	annoying, troublesome, discomforting, miserable, distressing, intense, horrible, unbearable, excruciating

This list shows what range of experience pain covers. Although the descriptions given are quite suggestive, they can nevertheless fall short of conveying to a non-sufferer the quality of a pain as experienced. This difficulty is conveyed by Kathleen Akins.

> We have all faced the difficulty of trying to communicate the nature of a particular phenomenal experience, good or bad. 'It was awful, absolutely horrible!!' you might recount, speaking of a bad migraine headache—but, apart from a fellow migraine sufferer, no one seems the wiser for your description. Frustratingly, despite the listener's own extensive catalogue of aches and pains, any elaboration on the 'horribleness' of a migraine seems to do little good. 'Yes, it's a bit like that but . . . .' one will hedge, when asked how a migraine compares to an ordinary headache, one caused by tension or sinus inflammation. Or is it like having a nasty hangover, a bad case of the flu, or like the stabbing pain one feels when the lights are suddenly switched on in a darkened room? 'It's sort of like that, except, only, um . . . well . . . much, much *worse*!' This is what a sufferer will typically reply, unsure, even in his own mind, what to make of such comparisons. (Does a migraine differ from a bad hangover only in intensity or is there in fact a difference in kind? Or does the difference in intensity *constitute* a difference in kind?) Ironically, the best description one can give, the descriptions that elicit the most empathetic sounds and nods, are usually not descriptions of the pain at all, but of the beliefs and desires that go along with the migraine. 'If I knew the migraine wasn't going to end, I'd seriously wonder whether life was worth living' or 'the pain is so intense, you don't even want to roll over, to find a more comfortable position in which to lie'—it is such thoughts that make clear the severity of the experience.[148]

Here we see how analogy alone can fail to communicate an experience of severe pain; similarly for any other debilitating emotional stress. Recourse has

[148] Kathleen A. Akins, "A Bat without Qualities?", pp. 260-261

then to be to describing the conative effect of the stress, what actions one might be prepared to take to end it. In fine narrative, emotion may barely be mentioned, being understood from the narrative description alone. The American writer Raymond Carver said that it is possible

> to write about commonplace things and objects using commonplace but precise language and endow these things—a chair, a window curtain, a fork, a stone, a woman's earring—with immense, even startling, power.[149]

Here is one of Carver's characters telling his own story:

> Everything was fine for the first year. I was holding down another job nights, and we were getting ahead. We had plans. Then one morning, I don't know. I'd just laid some bathroom tile in one of the units when this little Mexican maid comes in to clean. It was Holly had hired her. I can't really say I'd noticed the little thing before, though we spoke when we saw each other. She called me, I remember, Mister.
>
> Anyway, one thing and the other.[150]

We know what this man is feeling without being told, it is conveyed by the way of telling it—"Then one morning, I don't know."—it is older than mankind. Taking emotion as understood is all right in everyday life and in narrative prose, but following the same practice in philosophical analysis can lead to its unwarranted neglect.

Having exhibited the influences of affect and conation on mental processes, let us see how this can help us in understanding the various forms of mental representation. These influences are seldom taken account of by philosophers, despite their established presence in psychology, a situation due to some extent perhaps to the semantic influence, due to the amenability of cognition to semantic analysis in contrast to the non-cognitive dimensions of experience, though philosophers do include these under the guise of propositional attitudes such as fear and desire. A.C. Ewing is a philosopher who makes mention of the non-cognitive. Ewing writes, recounting the ancient Greek model:

> Turning to the more specifically mental side of ourselves, we find that it has been subjected to a threefold classification, represented by the distinction between affective, cognitive, and conative. . . . We must not, however, think of it as if the three sides operate quite separately. On the contrary practically all mental processes involve all three at once.[151]

It is important to remember Ewing's last point. Cognition, conation and affect do not contribute to mental states separately but in coordination (although they draw to some degree on different areas of the brain). It is clear that men-

---

[149] Quote on the cover of Raymond Carver's *Cathedral*

[150] Raymond Carver, "Gazebo", from *What We Talk About When We Talk About Love,* p. 19

[151] A.C. Ewing, *The Fundamental Questions of Philosophy*, p. 103

tal states differ in the proportional contributions of these three components, and it is also clear that despite the dominance of one or another in many mental states, all are present to some degree.

The example of pain is instructive in this respect. Pain is often described as if it possessed no cognitive component. For example, Colin McGinn writes that ". . . visual experiences represent the world as being a certain way, but pains have no such representational content"[152]. Part of the problem here may be due to a confusion of terminology. The word 'pain' is used for both a conscious experience and a local condition of the body to which it refers, the latter use being due perhaps to the dominance of the affective component of the experience of pain. Both of these uses of 'pain', however, concern aspects of the same mental state, a state of pain. McGinn, being a proponent of consciousness as an unresolvable philosophical mystery, uses 'pain' in the first sense, in which it acts as the epitome of pure conscious experience, that is, a mental state in which external reference is absent. (Later McGinn qualifies his position by saying that in respect of sensations "we cannot wholly eliminate the contribution of the less dominant [the third person] perspective", suggesting that his earlier statement about pain may have been an idealized view of it.) That the pain experience does contain a cognitive component referring to a localized pain is shown by the results quoted earlier of dissociation of its cognitive and non-cognitive components.

It is worth looking a little further into the scientific side of this for the insight it can give into the way in which the components of pain appear to be interacting. There is clear evidence from positron emission tomography (PET) that the neural construct associated with pain, besides involving perceptual and sensory areas of the brain, involves also areas concerned with the control of movement, *viz.* the motor cortex, the basal ganglia and the cerebellum. Wall comments:

> The results are so surprising that we may need a fundamental shift in the target that we are seeking to locate the mechanism for pain. We naturally think in steps. First we have sensation, followed by perception with its identification, classification and emotion, and lastly perhaps, motor action and behaviour. To match these three steps, classical thinking assigned separate functions to three parts of the brain: the sensory brain, the perception brain, and the motor-planning and action brain.
>
> Now we have to face these completely paradoxical PET scans. Some patients show every sign of perception of their pain but are not moving or even planning to move, yet parts of their brain previously assigned to the motor step are intensely active. Could it be that we have made a fundamental error in expecting a sensory box separate from the motor-planning box? Could it be that we in fact sense objects in terms of what we might do about them?

---

[152] Colin McGinn, *The Character of Mind*, p. 8

> Could it be that we have erected an artificial frontier between a sensory brain and a motor-planning brain which does not in fact exist? . . . we have seen here that the feeling of pain coincides with changes in every part of the body and in a distributed pattern in parts of the brain.[153]

Wall proposes

> that the sensation of pain itself is the consequence of our brain analyzing the situation in terms of what action would be appropriate. . . .
> Our understanding brains steadily combine all the available information from the outside world and within our own bodies with our personal and genetic histories. The outcomes are decisions of the tactics and strategies which could be appropriate to respond to the situation. We use the word 'pain' as shorthand for one of these groupings of relevant response tactics and strategies. Pain is not just a sensation but, like hunger and thirst, is an awareness of an action plan to be rid of it.[154]

Pain thus includes perception of a particular kind of threatening situation, an expectation of its development and a plan of action to control it.

Concerning the practice of philosophy, McGinn writes:

> So the philosopher wishes to know, without being roused from his armchair, what is *essential* to the various mental phenomena; the psychologist's aim is at once more ambitious and more modest—he wants to discover by empirical means the actual workings of this or that creature's mind.[155]

TABLE 1 DIMENSIONS OF MENTAL STATES
(Representative weights are shown respectively for vision and pain.)

STIMULUS			DOMAIN		
SOURCE	GENERAL DESCRIPTION	EXAMPLES	cogni- .	conation	affect
internal to body	sensation	touch pain hunger	(0, 1)	(0, 4)	(0, 5)
external to body	percep- tion	vision hearing smelling	(6, 0)	(3, 0)	(1, 0)
mental	thought	belief desire fear	(0, 0)	(0, 0)	(0, 0)

That is to say, in the words of Wall, philosophers seek to construct "idealized 'rational' sensory systems in happy ignorance of the working of living organ-

[153] Patrick Wall, *Pain; The Science of Suffering*, pp. 60-61

[154] Wall, *op. cit.*, pp. 161, 179

[155] McGinn, *op. cit.*, p. 4

isms"[156].

In view of the foregoing, a mental state may be conveniently analyzed using two independent dimensions, according to the scheme shown in Table 1, in which weights can be introduced into the boxes on the right hand side. (The weights that are entered sum to 10 and are for vision and pain respectively in the order entered.) Note that a vision, while being primarily stimulated from external sources (that is, the perceived object is located outside the body by the mental state), will also include auxiliary elements of mental stimulus, and may be combined with tactile sensation; and similarly for pain, *mutatis mutandis*. (For the weights entered in the table auxiliary elements are not taken into account.)

11. Propositional Attitudes and Intentionality of Mental States

Summary: Both Colin McGinn and John Searle use propositional attitudes to define intentional subclasses of mental states. It is maintained that all mental states are intentional, and can therefore be formulated as propositional attitudes.

(i) Emotional tone. Searle maintains that states of emotional tone do not belong to his subclass of mental states, which he calls Intentional, because they are not about anything. He also discusses the possibility that all Intentional states can be expressed in terms of belief and desire. It is shown that this is not possible, as the necessary component of affect is left out. This can often be supplied by emotional tone, which can consequently be a component of an intentional state, and in this sense is about the world.

(ii) The nature and the object of pain. In response to McGinn's assertion that pain is not intentional, Tim Crane considers what may be the object of a state of pain. As a realist he rejects a mental object in the sense of Brentano's intentional object. To obtain an objective pain object, Crane has to deny the subjective basis of the objective.

Colin McGinn introduces the class of "mental phenomena which have propositional content, that is, the ascription of which involves the use of a 'that'–clause, as in 'Jones believes that the sky is blue'"[157]. This is the class of propositional attitudes, which he equates with the state called thought in Table 1, and says "it seems more natural to accord central importance to how the attitude figures in shaping a person's propensities to act; the dispositional properties of propositional attitudes seem integral to their nature"[158]. But propensity to act is a criterion for the possession of a mental representation (see Section 6), and thus can be taken as integral to the nature of any mental state, and any propensity to act can be formulated as a proposition. It follows that any men-

156 Wall, *op. cit.*, p. 1

157 McGinn, *op. cit.*, p. 8

158 McGinn, *op. cit.*, p. 8

tal state where there is representation can be called a propositional attitude. Pain in particular includes, in the words of Wall quoted above, "an action plan to be rid of it" ("it" being the pain referred to by the state of pain), and is therefore a propositional attitude. As all mental states are propositional attitudes, the holding of a propositional attitude cannot be used to define a subclass of mental states. The source of the idea that there is such a subclass may be linguistic, as some states, such as that of belief, are more readily expressible in propositional form than others, such as pain. But surely the ready expressibility of a mental state in propositional form is of no relevance to its classification, unless it is perhaps connected to the idea that language is essential to thought. But then is language essential to the formulation of a desire, another propositional attitude, or to the cat's belief that there is a rat under the couch? Thus a mental state of pain, arising for example from a pain in the finger, which is a condition of the finger, refers to that pain in the finger, to that condition (there are here two references for the word 'pain'). The pain state can be expressed by the proposition, "I have a pain in my finger", just as a state of desire can be expressed by the proposition, "I have a desire . . .". Therefore a pain state can be classed as a propositional attitude. This does not apply to some exceptional pain states, such as those with little or no cognitive component, or some pain states of children who are still learning to identify the source of a pain, just as it may not apply to all states of desire—we do not always understand what we feel.

It was assumed in the foregoing discussion, in agreement with Brentano, that all mental states are representational, or intentional; that is, that a mental state refers to the world, or has "direction towards an object", or concerns the world in a more general way. This should not really be called an assumption, as it is integral to the conception here propounded of the relationship of mind and world that the world as we know it is constructed by the mind, it is the object of such a construct. Once this thesis is understood and assimilated, there should be no need to further establish that all mental states are intentional. But it behoves us to defend our thesis by showing how it answers to those who, like McGinn, maintain the contrary by pointing to supposedly non-intentional mental states. The areas of controversy that will be discussed in this section are, (i) emotional tone, as distinct from emotional reaction, (ii) the nature of the object of pain; and in the next section, qualia and consciousness.

(i) Emotional tone

John Searle writes as follows:

> First, on my account only some, not all, mental states and events have Intentionality. Beliefs, fears, hopes and desires are Intentional; but there are forms of nervousness, elation and undirected anxiety that are not Intentional. A clue to this distinction is provided by the constraints on how these

> states are reported. If I tell you I have a belief or a desire, it always makes sense for you to ask, “What is it exactly that you believe?” or “What is it that you desire?”; and it won’t do for me to say, “Oh I just have a belief and a desire without believing anything or desiring anything”. My beliefs and desires must always be about something. But my nervousness and undirected anxiety need not in that way be *about* anything. Such states are characteristically accompanied by beliefs and desires, but undirected states are not identical with beliefs or desires.[159]

Searle is putting forward an account of intentionality in which certain emotional states are not intentional. (He capitalizes ‘Intentionality’ for his particular usage of the term.) His criterion for Intentionality is the same as McGinn’s criterion for propositional attitudes, the possible description using a ‘that’–clause, or equivalent. But while McGinn excludes perception from propositional attitudes, Searle includes it under his criterion of Intentionality, because, as he writes,

> From the point of view of Intentionality, all seeing is seeing *that*: whenever it is true to say that *x* sees *y* it must be true that *x* sees that such and such is the case.[160]

Searle terms the ‘that’–clause a ‘condition of satisfaction’, which is analogous to the truth condition of a statement, the fulfilment condition of a promise, and the obedience condition of an order, ideas which he draws from his study of speech acts. He assures us, however, that

> In my effort to explain Intentionality in terms of language I am using our prior knowledge of language as a heuristic device for explanatory purposes. Once I have tried to make clear the nature of Intentionality I will argue that the relation of logical dependence is precisely the reverse.[161]

Having divided mental states into the Intentional and non-Intentional, Searle observes that

> Many philosophers think that belief and desire are somehow the basic Intentional states, . . . [162]

The reason for this is the idea that belief and desire together can produce, at both the conscious and unconscious levels, actions that are rational, given the belief and the desire; and knowledge of a person’s beliefs and desires can give a rational explanation for his actions. For example, if a person desires an apple and believes that there is an apple in the cupboard, then it is rational for him to act in accordance with his belief by going to the cupboard and taking the apple to satisfy his desire. Of belief and desire Searle says that

---

[159] John R. Searle, *Intentionality*, p. 1

[160] Searle, *op. cit.*, p. 40

[161] Searle, *op. cit.*, p. 5

[162] Searle, *op. cit.*, p. 29

> I shall construe them very broadly to encompass: in the case of belief, feeling certain, having a hunch, supposing, and many other degrees of conviction; and in the case of desire, wanting, wishing, lusting and hankering after, and many other degrees of desire.[163]

Based on these mental states, Searle proposes paradigm Intentional states, which we shall denote by Belief_I and Desire_I, "corresponding roughly to parts of the great traditional categories of Cognition and Volition"[164], that is, cognition and conation. He then asks whether all Intentional states can be reduced to Belief_I and Desire_I. Take, for example, the Intentional state, fear that *p*, where *p* is any proposition. Presumably we could write

$$\text{fear that } p \Rightarrow \text{Belief}_I \text{ that } (p \text{ is possible}) \;\&\; \text{Desire}_I \text{ that } (\text{not}-p),$$

where $\Rightarrow$ stands for implication. As the states of the right hand side of this statement include, by assumption, only cognition and conation, and fear that *p* has an affective component, the implication cannot be replaced by a statement of equivalence. If, however, we let Fear_I be the residue of fear when its affective aspects are removed, then we could perhaps define it thus:

$$\text{Fear}_I \text{ that } p =_{\text{def}} \text{Belief}_I \text{ that } (p \text{ is possible}) \;\&\; \text{Desire}_I \text{ that } (\text{not}-p).$$

As another example,

$$\text{amused that } p \Rightarrow \text{Belief}_I \text{ that } p,$$

but

$$\text{Amused}_I \text{ that } p \Leftrightarrow \text{Belief}_I \text{ that } p.$$

Devoid of its affective component, amusement is nothing more than belief.

It was observed that belief and desire are often sufficient for explaining action. Is this also true of Belief_I and Desire_I? We could ask, for example, is Fear_I that *p* sufficient to produce the same action as is produced by fear that *p*, namely action resulting in not–*p*? Or we could ask, is

$$\text{Belief}_I \text{ (there is an apple there) } \&\; \text{Desire}_I \text{ (I have the apple here)}$$

sufficient to produce

action (I move the apple that is there to here)?

The answer in each case depends on how the desire is motivated. Now it does not require much psychological knowledge to show that affect is usually integral to and is often a significant component of desire in so far as desire is regarded as productive of action. It is usual, for example, that desire to have an apple is based not only on a hunger drive, which could perhaps be regarded as purely conative, but also on anticipation of pleasure in eating it, which is affective. Likewise, in answer to our first question concerning Fear_I, there is no

---

[163] Searle, *op. cit.*, p. 29

[164] Searle, *op. cit.*, p. 30

doubt that there is in many cases an affective component of fear necessary for the production of action: after all, disposition to produce a certain kind of action is the function of an affect, as it is of all mental states. Consider the report in Section 10 on Scotch Terriers brought up to feel little pain: the only reason they lacked the desire to withdraw their muzzles from a burning candle was the lack of the affective aspect of pain.

Having shown that the affective component of a mental state cannot be neglected in considering the disposition to action that is the criterion for the existence of the state, we may now turn to Searle's stipulation that an affect that is not expressible as a propositional attitude is not to be taken as Intentional. One can argue against a stipulation such as this that does not lead to a logical contradiction only on grounds of its usefulness in view of existing facts and accepted theory. As it is not clear that there is any mental state that is purely affective, we must be concerned with affect as a contribution to, or component of, a mental state. In that capacity affect in many cases derives its direction, or reference, from its associated cognitive and conative components, and therefore cannot in such cases be regarded as possessing a reference on its own account, and is therefore non-Intentional. It follows that there are non-Intentional contributors to mental states that are essential in considering a state's disposition to action. Emotional tones fall into this category, such as those of nervousness, elation and undirected anxiety mentioned by Searle. Here is an example of an emotional tone that makes a contribution to an Intentional mental state.

Consider 'fear of Fido', Fido being a dog. In the above manner, let '$\text{Fear}_{\mathbf{I}}$ of Fido' be defined by

$\text{Fear}_{\mathbf{I}}$ of Fido $=_{\text{def}}$ $\text{Belief}_{\mathbf{I}}$ that (Fido is present) & $\text{Desire}_{\mathbf{I}}$ that (Fido be absent).

Full propensity to action when confronted by Fido requires the introduction of the affective side of fear into '$\text{Fear}_{\mathbf{I}}$ of Fido' to produce 'fear of Fido'. The affect that is introduced may be specific to Fido (due to some past encounter, for example), or specific to dogs (also due to past encounters perhaps), or it may be related to animals in general, or it may be a general nervousness. Which of these emotions can be regarded as non-Intentional? The first is certainly Intentional, as it refers to Fido. The next two are about the world in that they mention general features of the world, dogs and animals, so if an affect related to Fido is to be counted as Intentional, so presumably would an affect related to dogs or animals be counted as Intentional. The last is the one Searle would exclude from Intentionality, as it cannot be converted into the form 'nervous of *p*'. However it is usually possible to relate general nervousness, and other such generalized emotions, to some category of things in the world, even such a loosely defined category as ‘things unknown to the subject’, in which case it would be directed to things within that category but not to things outside it. In particular, a general nervousness may be directed towards Fido. More explicitly, let Np stand for Nervous Nelly is nervous of p, and let U be the class of things unknown to Nelly (or whatever class of things one may identify Nelly as being nervous of). Then Nelly’s general nervousness can be expressed by $(p)(p \in U \Rightarrow Np)$. On being confronted with Fido, whose behaviour is unknown to Nelly, as Fido $\in U$, NFido, that is, Nelly is nervous of Fido. Thus, if we now define ‘Fear$_{\mathbf{I}}$ of Fido’ by

Fear$_{\mathbf{I}}$ of Fido
$=_{\text{def}}$ Belief$_{\mathbf{I}}$ that (Fido is present) & Fido $\in U$ & Desire$_{\mathbf{I}}$ that (Fido be absent),

then (for expositional purposes using conjunction to represent a more complex association of affect with an Intentional state)

$$\text{fear of Fido} \Leftrightarrow \text{Fear}_{\mathbf{I}} \text{ of Fido } \& \ (p)(p \in U \Rightarrow Np)$$
$$\Rightarrow \text{Fear}_{\mathbf{I}} \text{ of Fido } \& \ N\text{Fido},$$

and this may lead to action resulting in the absence of Fido from the vicinity of Nervous Nelly. Thus general nervousness is an emotion that has application to produce, from insufficiently motivated Intentional states, mental states that lead to action. It is in this particular dispositional sense that general nervousness and other emotional tones are about the world.

Because there are non-Intentional contributors to mental states that are essential for their disposition to action, Searle’s definition of Intentionality is inappropriate as a general property of mental states. It must be acknowledged, however, that a condition such as general nervousness comes close to conditions that would be called personality traits, which cannot be regarded as being about the world, although they are instrumental in determining mental states.

(ii) The nature of the object of pain

McGinn’s view that pain is non-intentional was discussed earlier. Here we consider Tim Crane’s response. It was argued earlier in response to McGinn that the word ‘pain’ is used to refer to both the conscious experience and a local condition of the body, both of which are aspects of the state of pain, an intentional state directed towards the local condition. Crane writes in response to McGinn:

> Pains, on this [McGinn’s] view, are not *about* anything, they are not *of* anything, they *represent* nothing: they have no intentionality. Rather, pains are purely subjective qualities: their existence consists in the existence of a subjective state that tells us nothing about the external world.
>
> To hold this view is to distinguish pain from other cases of bodily sensa-

> tion where we are able to distinguish between the sensation and what it is of: sensations of warmth, of cold, of pressure, of tiredness, of hunger can all be described in terms of what they are sensations of, and what they are sensations of are properties of the external world (temperature, pressure etc.).[165]

In regard to the last statement, it should be pointed out that McGinn does not make the distinction Crane makes, for he writes that "bodily sensations do not have an intentional object in the way perceptual experiences do"[166]; that is, McGinn does not distinguish pain from other bodily sensations. Crane mentions hunger, as against pain, in which "we are able to distinguish between the sensation and what it is of", but his list of what sensations are of does not reach hunger: what is hunger of? Crane considers whether the solution can be

> that there *is* an object presented in a state of pain, but it is an internal or mental object. Now even if we reject mental objects in the case of the perception of the external world, can a case be made for their existence in the case of bodily sensation?[167]

'Internal object' refers to the intentional object of Brentano's thesis, which, as a good realist, Crane is anxious to deny the existence of, not realizing that a realist outlook can be accommodated by intentional objects, as explained in Section 9. As Brentano's thesis does not distinguish between external and internal intentional objects (as in perception and sensation respectively), or between primary and secondary qualities, the issue is really as to the objectivity of objects of sensation, the test case being pain.

Crane writes that a pain may be regarded as having objective existence because it can wake us up before we are aware of it; that is, it is independent of the conscious pain experience. On the other hand, it may be that "I was awoken by some non-conscious event in my brain, which then gave rise to pain when I became conscious"[168]. Whatever pain is, it need not be accepted as a mental object, but (following D.M. Armstrong[169]) can be taken as the object of "a form of perceptual awareness of one's body"[170], and similarly for other bodily sensations. This is given credence by the fact that pain is identified as being located in a part of the body:

> But what tells in favour of the perceptual theory is the fact that to concentrate on the ache, I must necessarily concentrate on the part of my body which aches; the mental object theory cannot explain this necessity.[171]

---

[165] Tim Crane, "Intentionality as the Mark of the Mental", pp. 234-235

[166] McGinn, *op. cit.*, p. 8

[167] Crane, *op. cit.*, p. 235

[168] Crane, *op. cit.*, p. 236

[169] D.M. Armstrong, *A Materialist Theory of the Mind*

[170] Crane, *op. cit.*, p. 237

[171] Crane, *op. cit.*, p. 237

On the contrary, it is a consequence of Brentano's thesis that with the intentional object is given its location, not in the mind, but in the space conceived by the mind, and this does not dictate a perceptual theory of sensation. In his efforts to find an objective object of sensation, Crane is denying the subjective, or mental, basis of sensation by trying to assimilate it to perception. No doubt there are similarities between sensation and perception, one being, ironically, that both are based in the subjective; but there is an important difference, that the object of a sensation, being concerned with processes that are not equally accessible to both the first and the third person, cannot be developed intersubjectively, and hence objectively, to the same extent as the object of a perception. The root of Crane's problem is his adherence to a realism that cannot realistically accommodate the subjective. This also lies at the root of the problem of qualia, which we now consider.

12. Qualia and Consciousness

Summary: According to Sydney Shoemaker we need an account of intentionality that accepts qualia while preserving materialism and functionalism. First, it is maintained that qualia are intentional, for it cannot be denied that they have a direction to the world. Nevertheless, as spectrum inversion shows, qualia of different individuals directed to the same object may differ within certain limits. Next is analyzed Frank Jackson's story of Mary, who knew all there is to know about the colour red but only discovered its quale on seeing it. Jackson's argument is found, after considering criticisms by Daniel Dennett and Paul Churchland, to have established that qualia, though physical in the sense of possessing neural correlates, cannot become completely known from their physical specifications. How, then, do qualia, and consciousness, arise? Do they constitute an unbridgeable explanatory gap? Read on.

Qualia and consciousness are two areas of philosophical discussion of the mind–world relationship which are generally acknowledged, or at least often claimed, to be beyond full rational comprehension. The view put forward here is that there is no problem with qualia and consciousness lying beyond rational, including scientific, comprehension. If there is a problem, it is not with the facts, but with finding a description that will accommodate them consistently.

Sydney Shoemaker writes that

> . . . we need qualia to make sense of secondary qualities

and that to defend the existence of qualia we need to oppose

> . . . the "intentionalist view" . . . which says that experiences have no introspectable properties other than intentional ones.

He acknowledges, however, that

> A possible view . . . is the "projectivist" view that in our perceptual experience we in some sense project what are in fact nonintentional features of our experiences, i.e., qualia, onto the states of affairs they represent. . . . This view reconciles the phenomenology of these cases—the fact that the nonintentional properties we are aware of in them are experienced as spatially located—with the claim that sensory experience involves qualia and awareness of qualia.[172]

A statement of the position that Shoemaker is drawing on would appear to be this: Secondary qualities, say the green of a leaf or the pain in a finger, are not objective properties, but are subjective qualities of our experience, called qualia, resulting from interaction between the perceiver and the perceived. Secondary qualities cannot therefore be intentional, not being actual properties of any object, but we nevertheless subjectively refer them to objects and thereby seemingly experience them as being in or of objects themselves. Secondary qualities can therefore be comprehended only through our subjective experience, and are intersubjectively communicable only by way of their subjective referral. The subjective experience of each individual can be known in its own particularity only by the individual himself. In particular, subjective experiences which have apparently identical subjective referral (in so far as differences may be evaluated by intersubjective communication) may differ between individuals, as in spectrum inversion. This contrasts with the primary qualities, which can be comprehended independently of direct subjective experience and can be objectively described.

Shoemaker writes that

> we need an account of these matters that accepts the existence of qualia and shows how commitment to their existence is compatible with materialism and functionalism.[173]

In order to preserve his idea of materialism and functionalism, Shoemaker endeavours to paint qualia as non-intentional, and to that end, as he says, he needs to oppose the thesis that all introspectable properties of experience—say all conscious experience—are intentional. That thesis follows from Brentano's Thesis that intentionality is the mark of the mental, but it does not follow from the thesis presented in Section 6, that the world is an object of constructions of human minds. Let us examine the thesis that all introspectable properties of experience are intentional.

In the first place, it is reasonable to assume, on functional grounds, that everything that goes on in the central nervous system is directed to, or has developed both by evolution and maturation for the function of, preserving the organism in the face of a hostile environment, of maintaining its homeo-

---

[172] Sydney Shoemaker, "Qualities and Qualia: What's in the Mind", pp. 101-102

[173] Shoemaker, *op. cit.*, p. 102

stasis. Does this preclude the existence of mental experience that has no intentional function? A cursory glance at evolution suggests that it does, for we find vestiges in our bodies of biological features that were at one time in our evolutionary past important for survival, such as a tail, and mental faculties, such as that of smell, that have diminished significantly as a result of reduced survival value in the presence of other developments, such as the neocortex. The long evolution of human kind and its progenitors has pared it of superfluous faculties. Likewise, in the maturation process, particularly that of the brain, we find that faculties not developed in early life are lost to development, and unused faculties atrophy. Turning to the intentional characterization of the mind, the tremendously varied mental apparatus that is innately available or can be developed for mental construction we can liken to the construction of scientific theory, where those parts that do not connect with the rest of a theory are removed and the model for the theory trimmed of its initially heuristically useful but now superfluous and misleading appendages. The list of such theoretical culling is a long one: refer, for example, to Maxwell's development of electromagnetic theory with the initial aid of an easily pictured system of "tiny idle wheels rotating in the medium between each pair of vortex cells", which he regarded "as a temporary and provisory hypothesis"[174]. As with science, so with the mind: it functions solely for direction to the environment and its own well-being, and for this it makes use of all the tools available to it. An idea that did not relate to the world in any way at all could not relate to any idea that does, and the mind would show a fundamental division for which there is no evidence.

It may occur to some readers that invoking evolution in support of a proposition concerning the human mind, from which the idea of evolution itself derives, involves a circularity, which might be put as follows: "Thought brings evolution into being, rather than the other way around, as in scientific realism. This implies that evolution cannot explain how we come to think as we do"[175]. This supposed circularity arises from an imprecision in use of the term 'evolution', and disappears when expressed thus: Thought brings the theory of evolution into being, and the theory of evolution implies that evolution brings thought into being. The theory of evolution is one means by which we are able to reach an understanding of ourselves—for it is inherent in the human situation that we can lift ourselves up only by our own bootstraps. Failure to distinguish evolution from its theory is a failure to distinguish word from object, and is the source of a possible misunderstanding of the present thesis. It is not maintained in this thesis that the world as we apprehend it is a

---

174 Mary Jo Nye, *Before Big Science*, pp. 73-74

175 Quoting from an anonymous referee (possibly Keith Campbell).

construct of the human mind; it is maintained that the world as we apprehend it is *the object of* a construct of the human mind. Thus the statement, *S*, that thought brings evolutionary theory (a human construct) into being does not imply the statement that thought brings evolution (an object of evolutionary theory) into being. Nor does it imply that evolution does not exist except as an object of evolutionary theory; that is, it does not deny the scientific realist's claim. In fact the statement *S* does not imply anything about evolution, as it is only through evolutionary theory that anything can be stated about evolution, and *S* is not a statement of evolutionary theory. The claims of scientific realists are therefore without content. To attempt to speak of evolution other than by means of its theory, to ascribe to it some extra-scientific property of reality, is to subscribe to what Putnam calls 'metaphysical realism' (Part II, Section 7), an idea that has been more deleterious to the advance of human thought than almost anything else; and it is pure philosophy, not science.

As we are particularly concerned with qualia, and the idea that they are non-intentional, let us now consider this. Shoemaker would say, presumably, that the colour green is not intentional because physics has shown that there is nothing objective that the property green refers to. There is a loose association, of course, between the colour green and light of wavelength in the vicinity of 0.54 of a micron, but this is not sufficient to call that band of light an intentional object of green qualia. In any case, there are many other stimuli for the experience of green, or any other colour, many being dependent on observational conditions. (Refer to C.L. Hardin, *Color for Philosophers*, for information on this.) Thus the property green does not point to a materialistically objective classification (a natural kind). However, restriction of the idea of intentionality in this way is clearly designed to preserve materialism. The sense in which 'intentional' is used in this thesis is not restricted in such a way, but corresponds to the "projectivist view" described by Shoemaker above, that features of our experience, including qualia, are projected onto states of affairs they represent. It is clear that this use accords with our mental functioning, for we do not only project the green of our experience onto perceived objects, to colour them in so to speak, but see these objects as green objects. Turn aside from this, and we are entering a world of physical description alone. Taking a broad view of intentionality does not force us to turn away from physicalism, however.

A test for a view of intentionality that encompasses qualia is provided by the thought experiment of inverted qualia. It was mentioned earlier that "the subjective experience of each individual can be known in its own particularity only by the individual himself". Does it follow that it is not, say, the actual experience of green that is intentionality directed towards an object, but only the distinction in colour that the experience of green enables us to make that is so directed, and similarly with other such cases? From the functional point of view the answer would appear to be yes, in which case whatever colour experience is directed towards the same object by different individuals would be called an experience of green: the quale is named after its intentional object, not for some intrinsic property it may have. Thus it is possible that there could be a complete spectrum inversion between individuals, with yellow and blue, green and red and so on changing their intentional roles. Although some variation in qualia clearly occurs, as it does with all bodily features[176], complete spectrum inversion is empirically unlikely except as an aberration, for there could well be a limit to the variation in the neural correlates of colour experiences due to functional considerations: if my red of the sunset is your green of the grass, one of us may be at a distinct perceptual disadvantage; even more bizarre, if my pain experience is your pleasure experience and vice versa, one of us will soon be eliminated. However it turns out empirically, however our individual experiences may differ and whatever the sphere of mental activity, qualia remain intentional and are given the names of their intentional objects as established intersubjectively, the only constraint being the empirical possibility of intersubjective processes.

It has been maintained by many philosophers that complete knowledge of primary qualities does not yield knowledge of secondary qualities, and hence of qualia. Thus qualia are in a sense not physical. This view has been reinforced by various philosophical thought experiments. One of the best known is Frank Jackson's story of Mary, a brilliant scientist who, having been confined to a black and white room since birth, has had no experience of colour, but

> knows all the physical facts about us and our environment, in a wide sense of 'physical' which includes everything in *completed* physics, chemistry, and neurophysiology, . . .
>
> It seems, however, that Mary does not know all there is to know. For when she is let out of the black-and-white room or given a colour television, she will learn what it is like to see something red, say. . . . Hence, physicalism is false.[177]

What does Jackson mean by "physicalism is false"? He writes:

> Physicalism is not the noncontroversial thesis that the actual world is largely physical, but the challenging thesis that it is entirely physical. This is why physicalists must hold that complete physical knowledge is complete knowledge simpliciter. For suppose it is not complete: then our world must differ from a world, *W(P)*, for which it is complete, and the difference must

[176] For example, polymorphism of the gene for red pigment molecules of the retina produces differences in possible colour constructions, and thus colour qualia. See Donald Hoffman, *Visual Intelligence*, pp. 132-133.

[177] Frank Jackson, "What Mary Didn't Know", p. 291. See also Jackson's "Epiphenomenal Qualia".

> be in nonphysical facts; for our world and *W(P)* agree in all matters physical.[178]

Thus in the world *W(P)* there can be complete knowledge of all facts, whereas in our world, which differs from *W(P)* if physicalism is false, there can be complete knowledge only of all physical facts. "Physicalism is false" therefore means that there is at least one fact, about which knowledge is possible, which is not a physical fact. Such a fact is "what Mary didn't know", namely "what it is like to see something red". Can this be called a fact? For convenience of exposition it may be allowed as a fact, but it certainly is not a fact that can be described objectively, and to allow it as a fact that can be experienced may be misleading. We shall return to this question, which is fundamental to understanding qualia and consciousness. But for the moment let us record what Jackson's argument, if it is valid, can fairly be described as having established.

Physicalism is Incomplete A full physical description of a phenomenon does not produce experience of it.

A philosopher with a linguistic orientation may like to insist that this conclusion should read, "A full physical description of a phenomenon does not include *a description of* the experience involved"[179]. Whether there are aspects of the experience of seeing red that a physical description, in Jackson's "wide sense of 'physical'", does not include is a moot point—at least we can say that all physical correlates of experience are subject to full physical description. But whether or not the above formulation of Physicalism is Incomplete is what Jackson intended, it must be clear that the knowledge that his thought experiment shows to be lacking in world *W*(*P*), but to be present in our world, is knowledge of what it is like to see red, it is the actual experience of seeing red that Mary had not previously had; and this is not knowledge by description.

The conclusion that physicalism is incomplete is one that most, apart from confirmed materialists, would be prepared to subscribe to. It should be noted, however, what the conclusion that physicalism is false *cannot* be taken to imply: it cannot be taken to imply the anti-physicalist thesis that we are not physical structures, in particular that there do not exist neural correlates of mental states, including neural correlates of qualia, although it is nevertheless consistent with this thesis.

Daniel Dennett is intent on showing that, given Mary's physical knowledge, she could not have had anything to discover when released from her black and white bondage. He writes about Mary:

> And it may also occur to us that if the first coloured things she is shown are, say, unlabelled wooden blocks, and she is told only that one of them is red

---

[178] Jackson, *op. cit.*, p. 291

[179] As the previously mentioned anonymous referee insists.

> and the other blue, she won't have the faintest idea which is which until she somehow learns which colour words go with her newfound experiences.[180]

But this occurs to Dennett only to reject it, for he puts the following words into Mary's mouth (with the text changed to relate it to the wooden blocks):

> "You have to remember that I know *everything*—absolutely everything—that could ever be known about the physical causes and effects of colour vision. So of course before you brought the [blocks] in, I had already written down, in exquisite detail, exactly what physical impression a [red] object or a blue object (or a green object, etc.) would make on my nervous system. So I already knew exactly what *thoughts* I would have (because, after all, the 'mere disposition' to think about this or that is not one of your famous qualia, is it?)."[181]

Let us examine Dennett's argument. First, it may, for the sake of the argument, be assumed that Mary, on seeing the red and blue blocks, did have experiences of red and blue qualia. (It is most unlikely, though, that she could have had such experiences, as she would not have had the requisite visual experience in the developmental stage of her life for the formation of the necessary neural connections.) What Dennett needs to show is that these qualia do not constitute a new experience for Mary. Dennett makes the reasonable assumption that the red and blue qualia would have neural correlates. Based on her neurological knowledge, Mary says that she was able to predict the effect of the various neural correlates of colour qualia on her neural structure, and thus to predict what thoughts these neural effects would correspond to. By comparing her actual thoughts with her predictions, Mary was able to identify the colours of the blocks.

There are two flaws in this argument. First, as Mary had had no prior colour experience, she would not have had any thoughts that would enable her to identify colours, only thoughts that colours differ. Second, even if she did have thoughts enabling her to identify colours, it does not follow that experiencing the red and blue qualia was not a new experience, only that she *behaved* as if it were not a new experience. Dennett appears to have been ensnared by his behaviourist tendencies.

An idea as to what underlies the discussion about qualia is given in a criticism of Jackson's argument by Paul Churchland. He puts Jackson's argument in the following form:

> (1) Mary knows everything there is to know about brain states and their properties.
>
> (2) It is not the case that Mary knows everything there is to know about sensations and their properties.

---

[180] Daniel C. Dennett, *Consciousness Explained*, p. 399

[181] Dennett, *op. cit.*, pp. 399-400

Therefore, by Leibniz's Law,

(3) Sensations and their properties ≠ brain states and their properties.[182]

It is worthwhile to set this argument out symbolically. Let B be the set of facts about brain states, S the set of facts about sensations and experiences of sensations (qualia), MKx = Mary knows x. Churchland's rendering of Jackson's argument is then:

(1) $(x)(x \in B \Rightarrow MKx)$

(2) $\sim(x)(x \in S \Rightarrow MKx)$

∴ (3) $S \neq B$

This is a valid argument (and does not depend on Leibniz's Law for its validity). Churchland points out that the use of the word 'know' is equivocal between (1) and (2): in (1) 'know' has the sense of 'know that', while in (2) 'know' has the sense of 'is acquainted with'. If we let MAx = Mary is acquainted with x, then premise (2) should be replaced by

(2′) $\sim(x)(x \in S \Rightarrow MAx)$

Churchland notes that this corrected rendering of Jackson's argument is invalid. Observe, however, that this argument can be made valid by the introduction of the additional premise

(4) $(x)(MKx \Rightarrow MAx)$

In fact, it is easily seen that the addition of premise (4) is a necessary and sufficient condition for the validity of the argument. The new valid argument is thus:

(1) $(x)(x \in B \Rightarrow MKx)$

(2′) $\sim(x)(x \in S \Rightarrow MAx)$

(4) $(x)(MKx \Rightarrow MAx)$

∴ (3) $S \neq B$

What is stated by (4)? Take the element $r \in S$, where r = the sensation of the colour red. That Mary has full physical knowledge of r can be expressed, MKr; that Mary has experience of r can be expressed, MAr. Thus $\sim(MKr \Rightarrow MAr)$ expresses the fact about Mary, prior to her release from the black and white room, that her physical knowledge of r did not produce experience of r. Similarly for other sensations, taking Mary to be a representative individual (thus for simplicity we shall not quantify over individuals). For any factual $x \in S$ or any $x \notin S$ we could take MAx to be equivalent to MKx. From these remarks, $\sim(x)(MKx \Rightarrow MAx)$ can be taken to be a statement of the thesis that *Physicalism is Incomplete*. Thus statement (4) expresses

---

[182] Paul Churchland, "Reduction, Qualia, and the Direct Introspection of Brain States", pp. 61-62

Physicalism is Complete A full physical description of a phenomenon produces experience of it.

Churchland's rendering of Jackson's argument is therefore valid if and only if *Physicalism is Complete*.

The conclusion of that argument is (3) $S \neq B$. What does this say? Nothing, apparently, as it follows from the definitions of the sets S and B that $S \neq B$. On the other hand, if we allow identity between S and B in the sense that theories of S are reducible to theories of B (see Section 8 for reference to reduction), then $S \neq B$ says that S is not completely reducible to B, or roughly speaking, qualia do not possess neural correlates. (Alternatively one might take $S \neq B$ to say that S is not supervenient on B.) It is understandable that Churchland, who argues in favour of eliminativism via theoretical reduction, would want to undermine an argument for $S \neq B$; but ironically it is the introduction of the *Physicalism is Complete* premise that yields a valid argument for $S \neq B$. How can this be? Quite simply: the lack of neural correlates for qualia ensures that *Physicalism is Complete* is an empty statement—there is no physical description of a quale from which experience of it could be produced.

We shall now leave Churchland and return to Jackson to see whether his argument can be saved. We shall take his conclusion to be that *Physicalism is Incomplete*, as set forth earlier. This can be obtained from two premises summarizing the story of Mary as follows:

(1′) $(x)(x \in S \Rightarrow MKx)$ [Mary knows everything about sensations.]

(2′) $\sim(x)(x \in S \Rightarrow MAx)$ [Mary has not experienced all sensations.]

∴ (5) $\sim(x)(MKx \Rightarrow MAx)$ [The thesis *Physicalism is Incomplete*.]

Proof: From (2′), $\exists\ r \in S$ (the sensation of the colour red) such that $\sim MAr$. From (1′), MKr. Thus $\sim(MKr \Rightarrow MAr)$, from which (5) follows.

Note that this does not use the set B, but allows that $S = B$ in the sense mentioned above.

We conclude that both Dennett's and Churchland's arguments, based as they are on philosophical preconception rather than disinterested analysis, fail to show that Jackson's argument is unsound; and that Jackson's argument, while needing care in its presentation and interpretation, is fundamentally sound.

The problem that is crystalized out, so to speak, by the concept of qualia is how to take account of the subjective, which is known also by its variants, the soul, consciousness, the first person point of view, etc. Descartes started this off in its modern unfolding by proposing a duality of mind and body. Since then philosophers who have been unwilling to accept an understanding based on a duality have sought to find a basis in a unity centred on one or the other of mind and matter, subjective and objective. The principal shortcoming of a duality is that it necessarily leaves the connecting link between the two parts incompletely accounted for; for once that linkage has been satisfactorily explained, there is no longer a final duality, but a unity of the two parts united by their linkage.

There is only one way to resolve this issue, and that is to look to the facts, and for them we shall refer back to the preceding pages of this thesis. At the opening of this section we see Shoemaker claiming that ". . . we need qualia to make sense of secondary qualities". He could just as well have said that we need qualia to make sense of primary qualities. The fact is that each of primary and secondary qualities is needed for the other in some sense. Secondary qualities can be understood in terms of interactions between ourselves and the world only once we have some notion of primary qualities—the idea of secondary qualities in their modern expression was established in the seventeenth century only once basic primary qualities had been developed in modern science. But once we have recognized the existence of secondary qualities as arising by subjective referral from our own experience of the world, we realize that primary qualities themselves develop from those secondary qualities: the notion of force (and weight) from feelings of stress in our limbs, time from the regularity of passing events, energy from toil over time, temperature from feelings of warmth and cold, and so on. And the science of these primary qualities has its basis in experiment evaluated with the help of secondary qualities. (The way in which interaction occurs between primary and secondary qualities was explained earlier in Section 3.)

As science has developed, two inescapable facts have become apparent.

(1) The world as we perceive it, sense it and know it is a structure that is based ultimately, in terms of the idea of intentionality, on constructs of individual minds (refer to Section 6).

(2) We are ourselves physical structures.

Here apparently the physical rests on the subjective, and the subjective rests on the physical, so resulting in groundless explanation. But, if these two facts are combined into a single idea, the following is obtained:

(3) As an object of their subjective experience, individuals collectively create the world as an explanatory and predictive structure, encompassing physics and allied sciences, by means of which an understanding is obtained both of their sensory environment and of themselves, and their integrity as homeostatic systems is protected.

That explanatory structure provides understanding of the physical basis of the subjective experience from which it derives, in the form of a physical description of the processes that give rise to it, but it cannot physically explain or describe what is termed the quale, the quality of that experience itself, for as Frank Jackson's story of Mary illustrates, physicalism is incomplete. For philosophers this one supposed explanatory gap[183] in the circle of our understanding has, since physicalism has come to pre-eminence in our thinking, become perhaps the quintessential philosophical problem, the final distillation of the age-old question of the source of our animus (refer to Figure 8).

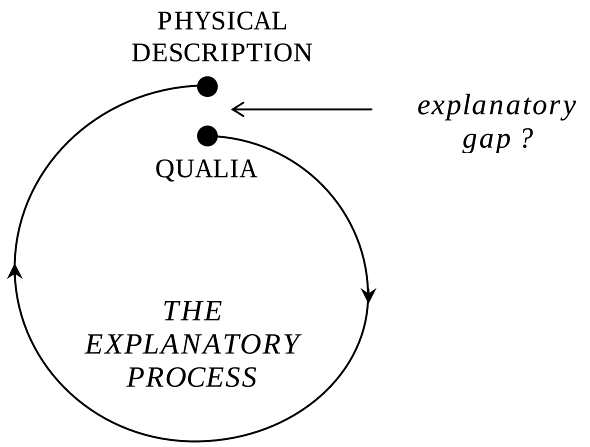


FIGURE 8

It is part of the challenge of the more general problem of consciousness, the fundamental part according to many, related to the problem of phenomenal consciousness. The challenge of the problem of qualia, and of the more general problem of consciousness, has been met in several ways, both by philosophers and non-philosophers:

1. Traditionally by relegating these entities to the spiritual sphere.
2. By attempts to account for qualia in philosophical terms, such as self-awareness or what it is like to be the subject experiencing qualia. Thomas Nagel is a well known exponent of the latter view.
3. By attempts to account for qualia in physical terms, perhaps by as yet unexamined neurological processes, based for example on quantum mechanics. This is the view of the physicist Roger Penrose[184].
4. By classifying the problem as being within the realm of natural processes, but beyond the capacity of humans to solve, whether due to the inherent nature of the problem or accidentally. This view is put forward by Colin McGinn[185].
5. By attempts to show that there is no gap between the physical nature of the brain and mental experience, either because qualia do not exist or be-

---

[183] Referred to as "the gap between subjective and objective" by Thomas Nagel, "What Is It Like To Be a Bat?", p. 178

[184] Roger Penrose, *The Emperor's New Mind*

[185] Colin McGinn, *The Problem of Consciousness*

cause they are epiphenomenal and the neural correlates of qualia are sufficient for an understanding. Daniel Dennett and Paul Churchland are exponents of this class of solutions.

6. By maintaining that there is no problem of qualia or consciousness, either because these concepts are not or cannot be properly specified, or because the whole issue arises from a verbal confusion. Kathleen Wilkes falls somewhere under this description.[186]

Of one thing we can be certain, that each quale, by definition, can be known by acquaintance only by its possessor, and is therefore beyond complete description. Qualia, therefore, but not the mental experiences of which they are the qualities, must lie outside any detailed description of things. Wilkes provides a nice analogy for this:

> Just as a subway map often helpfully has an ancillary arrow stating 'YOU ARE HERE', so the notional, complete psychophysiological-physical picture of the world could be supplemented for its users: 'THIS IS YOU', from which the way things are experienced from that position may be inferred. The addition YOU ARE HERE to a map is, evidently, not the cartographer's business, and such maps could not be sold at bookstores; similarly, the addendum THIS IS YOU to a completed psycho-physical account is not a proper part of the scientist's concern.[187]

Nagel acknowledges that to understand "physical events in objective terms" it is not necessary to "understand the phenomenal forms in which those events appear to the senses". Speaking of different species, he writes:

> Thus it is a condition of their referring to a common reality that their more particular viewpoints are not part of the common reality that they both apprehend. The reduction can succeed only if the species-specific viewpoint is omitted from what is to be reduced.[188]

But, intent on avoiding "neobehaviourism", Nagel maintains that the subjective point of view cannot be ignored in an understanding of our internal mental life:

> If we acknowledge that a physical theory of mind must account for the subjective character of experience, we must admit that no presently available conception gives us a clue how this could be done. The problem is unique. If mental processes are indeed physical processes, then there is something it is like, intrinsically, to undergo certain physical processes. What it is for such a thing to be the case remains a mystery.[189]

It is surprising that there should be such a diverse range of views on qualia and consciousness, for this area of controversy has become an arena in which

---

[186] Kathleen V. Wilkes, "Is Consciousness Important?", pp. 223-243

[187] Wilkes, *op. cit.*, p. 241

[188] Thomas Nagel, "What Is It Like To Be a Bat?", p. 175

[189] Nagel, *op. cit.*, p. 175

all shades of philosophical ideology are exercised. This may be partly due to the fact that aspects of consciousness that appear to be proper subjects for scientific study, such as attention and awareness, are included with those that are of philosophical concern, thus misleading philosophers into the belief that areas of study such as phenomenal consciousness are suitable for philosophical, if not scientific, investigation. However that may be, the problem of qualia should perhaps be described not so much as a quintessential philosophical problem as a quintessential example of philosophical confusion about a matter that is inherently simple.

Nagel is very near to resolving the matter when he writes that

> . . . the fact that an organism has conscious experience *at all* means, basically, that there is something it is like to *be* that organism. . . But fundamentally an organism has conscious mental states if and only if there is something that it is like to *be* that organism—something it is like *for* the organism.[190]

Something it is *like* to be invites comparison, and hence description; and if none is forthcoming, it "remains a mystery", as Nagel says. But there is nothing it is *like* to be me, in all my individuality (unless it is something like being you), there is only *being me*, and me being me. Likewise, Nagel writes (as quoted above) that "if mental processes are indeed physical processes, then there is something it is like, intrinsically, to undergo certain physical processes". But we do not *undergo* physical processes, we *are* the physical processes. Of course in ordinary speech we do speak as if we *undergo* physical processes: this reflects modes of expression deriving from our natural dualist conception of body and mind, which does good service in everyday life. But philosophy should not be concerned with reflecting everyday life, but with finding consistent ways of expressing the truth, of which dualism is not a part. Therefore we must not say that we *undergo* physical processes, but that we *are* the physical processes. The difference is the difference between describing a thing in the third person (my body for instance) and being the thing, and this is a difference that applies to anything: to a stone, to the weather, to ourselves. For a stone or the weather it is the difference between having a representation of the thing and being the object of the representation. The object, as an existing thing, has power to change things, whereas its representation does not. As the rhyme goes: sticks and stones can break your bones, but names will never hurt you. And as Searle said: "No one supposes that computer simulations of a five-alarm fire will burn the neighbourhood down or that a computer simulation of a rainstorm will leave us all drenched. Why on earth would anyone suppose that a computer simulation of understanding

---

[190] Nagel, *op. cit.*, p. 166

actually understood anything?"[191] Thus no description of a particular human being will produce that particular human being's experience. ('Description' is used here in a broad sense to include working models.)

A human being is not quite like a stone or the weather, of course, as neither a stone nor the weather experiences anything; but it is like them in this respect, that a human, a stone and the weather all have an existence, and this is a different thing from a computer simulation or a description of any of them. What differs between a stone and a human being is the nature of their existence. It is in the intentionality of a human being's existence that we find the key to qualia and consciousness, and through this the awareness of the *co*-existence of intentional objects with that of the intentional subject. The only mystery, or challenge, lies in the extraordinary complexity of the human nervous system from which human intentionality derives, for there is no more complex thing known to us in the universe.

And what of the explanatory gap that so concerned Nagel? (See Figure 8.) There is no *explanatory* gap. There is only a virtuous explanatory spiral of the kind dealt with in Section 3. The gap shown in the picture, at the point where the qualia are, is, if you like, an *existential* gap, the point from which all existence originates, ourselves—as Descartes said.

The understanding of consciousness is little more than a corollary to the foregoing account of intentionality, for a conscious state is just an 'active' intentional state, one that is, so to speak, before the mind and is concerned with what one is attending to, and this is a psychological/neurophysiological rather than a philosophical problem[192]. Intentionality does for consciousness what it does in accounting for visual experience: being conscious of a tree is having a tree as the object of an active intentional state. Likewise, being self-conscious is having oneself as intentional object, and the conscious process of thinking is active participation in an intentional state (the construction of intentional states may be consciously guided, but is mainly unconscious).

A final observation: The ease with which a resolution of the so-called problem of consciousness can be obtained from an account of the human situation that is faithful to the facts while adhering to no philosophical ideology must surely give support to the conclusion of Part I of this essay, that philosophy is usually more of an obstacle than an aid to the attainment of

---

[191] John Searle, "Minds, Brains, and Programs", p. 423

[192] "Consciousness is involved only in activities stemming from the associative regions of the cortex", and is quite likely to be due to "the synchronization of the billions of cortical nerve cells with the trillions of synapses—which are all the while under the influence of the reticular formation, thalamus, hippocampus and limbic systems. The astronomically high occurrence of internal rewiring in the associative cortex adds weight to this idea". See Gerhard Roth, "The Quest To Find Consciousness", p. 39.

knowledge and understanding. In support of this observation, consider the following proposal by a physicist stating in outline, though in terms that may be "suspect in the eyes of the philosophical police"[193], essentially the thesis that has been presented in Part II of this essay.

> Like many people faced with the problem of consciousness, Blackmore starts by assuming the existence of an independent external material world and then asks: "How do you get from a real magazine composed of atoms and molecules to your experience of seeing it?"
>
> Well, quite. How could you? What is commonly misunderstood is that the so-called external real world, along with the concept of constituent particles, is a model derived from conscious experience. In other words, it is consciousness, not physical matter, that is the fundamental "stuff" of the Universe. This approach immediately dispenses with the "hard problem" by making mind (consciousness) the essential reality, and matter a construct of mind.
>
> *Keith Atkin*[194]

But of course Keith Atkin may have got his ideas from some philosopher.

13. Conclusion

In the thesis presented here the aim has been to accommodate known facts about humans and their situation, both commonplace and scientific, while employing only a minimum of conceptual construction, in an attempt to dissolve the central philosophical problems that have remained unresolved since philosophy began in ancient Greece. The motivating idea has been the following: As philosophy is principally concerned with commonplace facts and introspection, selected, idealized and analyzed so as to conform with an ideology[195], the only hope for dissolving philosophical problems is by following scientific practice in seeking a philosophically neutral description that accounts for the principal objectively established facts. The description offered

---

[193] Albert Einstein, "Remarks on Bertrand Russell's Theory of Knowledge"

[194] Letter to the editor, *New Scientist*

[195] of which there is a profusion. Here is a sampling:

absolutism actualism atomism behaviourism
coherentism compatibilism determinism dualism
empiricism epiphenomenalism essentialism evolutionism
existentialism externalism foundationalism functionalism
idealism incompatibilism instrumentalism interactionism
internalism irrationalism logical atomism logical positivism
logicism materialism minimalism monism
mysticism objectivism occasionalism operationalism
panpsychism phenomenalism pluralism positivism
pragmatism psychologism quasi-realism rationalism
realism reductionism representationalism scepticism
selectionism sensationalism solipsism subjectivism
verificationism

by this thesis is claimed to have achieved the following:

1. To provided continuity between everyday and scientific understanding, and between observation and theory in science. This has only been sketched in outline.
2. To give an account of sense perception that clarifies the mind–world relationship, and establishes the idea of reality in descriptive rather than ideological terms, thus diffusing the notions of metaphysical realism and idealism (scepticism).
3. To explain the subjective–objective connection which underlies all human knowledge by means of the idea of intentionality.
4. To clarify the philosophically supposed 'mystery' or 'hard problem' of the nature of subjective experience, or qualia.
5. To reduce the philosophical 'problem of consciousness' to the intentional character of the mind–body relationship.

Philosophical problems may be epitomized by the simple problem of mirror inversion. If you hold a piece of paper with PHILOSOPHY printed on it up to a plane mirror, you will see YHPOSOLIHP in the mirror. The image is a horizontal reversal of the reflected object—the left side appears on the right and the right on the left, but up is still up and down is still down. The question is: why does a plane mirror produce an image that is transposed horizontally and not vertically? Or as a child might put it on seeing its image in a mirror: how does the mirror know to turn me from left to right but not upside down? Geometrical optics will explain what we actually see, but as it is indifferent to vertical and horizontal, it will not answer the question in the terms in which it is asked. The problem, therefore, is not with the facts, but with the particular way in which they are being thought about, or expressed. Adults are often unable to see that there *is* a problem, as they have become accustomed to the properties of mirrors and how we talk about them. This is similar to many people's reaction to the problem of vision, as Francis Crick observes:

> I am often asked by nonscientists, usually at the dinner table, what I am working on. When I say I am thinking about some of the problems of the visual system of mammals—that is, how we see things—there is usually a slightly embarrassed pause. My questioner is wondering why there should be any difficulty about something as simple as seeing. After all, we open our eyes and there the world is, large and clear, full of objects in vivid Technicolor, without our having to make any appreciable effort. It all seems so delightfully easy, so what can be the problem?[196]

Philosophical problems are like the problem of mirror inversion. The physical facts are usually clear, and where they are not known it is the busi-

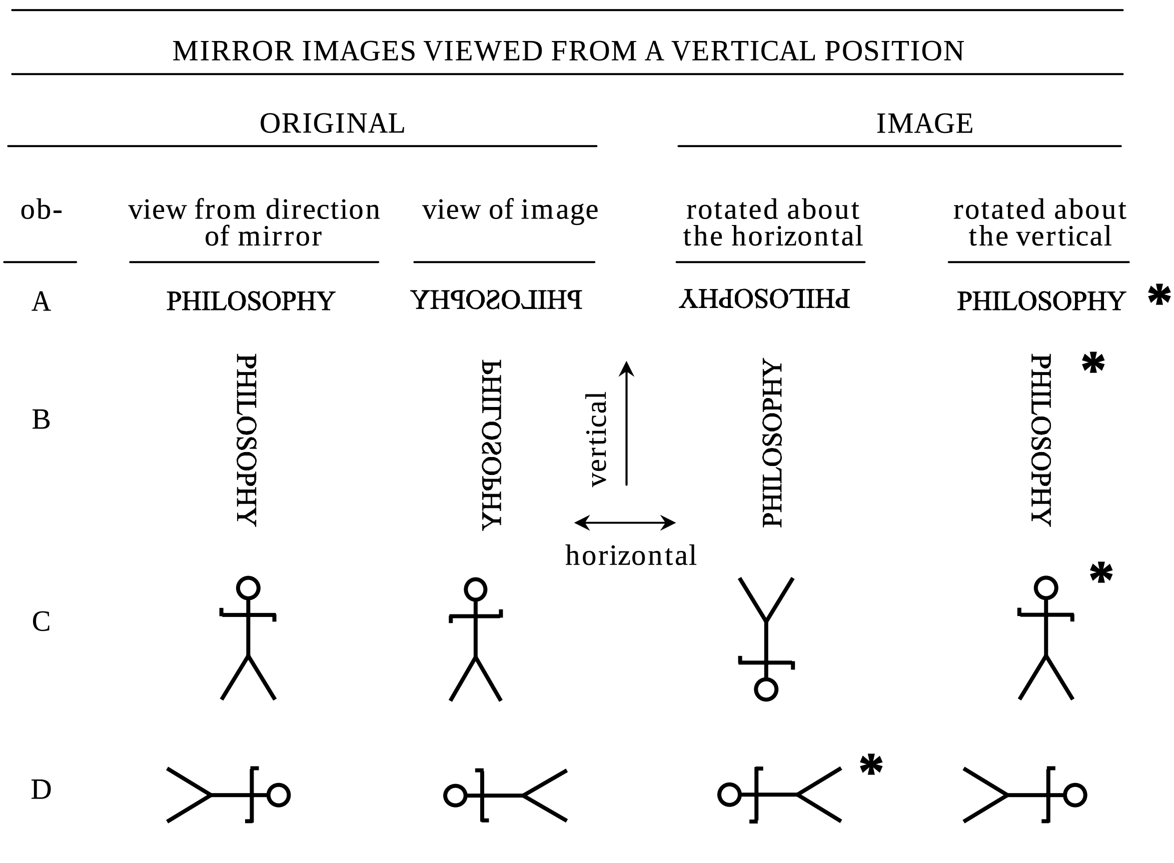
---

[196] Francis Crick, *The Astonishing Hypothesis*, p. 23

ness of science, not philosophy, to discover them. A philosophical problem has to do with how we look at a situation, and this is often well concealed from us. This is because the way we look at a situation has to do with our own functioning, which we take for granted, not with the laws of physics. Science established its laws by abstracting from our own way of looking at things; in order to understand ourselves we have then to reconstruct the way we look at things within the knowledge science gives us. Two important philosophical problems that touch directly on physics are the direction of time (the laws of physics are independent of it) and the interpretation of quantum theory (there is no interpretation of it consistent with our naturally developed concepts, but this is no handicap for non-philosophically minded physicists). As seen in Part I, a new advance in scientific knowledge activates philosophy to account for it in human terms—philosophy itself does not produce knowledge. The philosophical problems considered in this essay are of such a kind.

To see how philosophy overlays human values and interests onto physical facts, it is worth returning to the mirror inversion problem. Table 2 displays the physical facts. By a vertical or horizontal rotation of the image is meant its rotation through an angle of 180° about a vertical or horizontal line through its centre (corresponding respectively to a horizontal or vertical reversal of its appearance). Note that a rotation of an image changes its parity (equality with object), and a further rotation restores parity. If one rotation is vertical and the other horizontal, both left–right and up–down reversal occurs, otherwise the original view is restored.

TABLE 2



The ideal mirror view of object A, B or C is the normal front view (indicated by an asterisk). As the image is a rotation of this view about the vertical, we say that the image is a horizontal reversal of the object. How do we account for the lack of vertical–horizontal symmetry in this statement? Just by the fact that it is viewing from a vertical position that is under consideration. If we were considering viewing from a horizontal position in a fixed direction, left or right, then the words 'vertical' and 'horizontal' would need to be interchanged in the above conclusions. The case of object D, a figure with near vertical symmetry, appears to be different from the others. Because of the near symmetry, in this case the ideal mirror view has the head in the same direction as the image (indicated by an asterisk), which is of course near to how we normally see ourselves when lying on our side, so that we are inclined to say in this case that the image is a vertical reversal of the original. This is not so in the case of object A, which is also in a sense lying down, because a word has no symmetry and needs to be upright for comprehension. We can conclude, therefore, that the way we describe a mirror image depends upon (a) the symmetries of the object in so far as they interest us, (b) what aspect of the object we need to see preserved in the image, and (c) from what orientation we view the image.

If there is difficulty in uncovering the effects of human values and interests on descriptions of observed phenomena as simple as mirror images, how difficult it must be to uncover such effects when the description is preserved in philosophical discourse where the phenomena are far more complex and human values and interests are far from being understood and agreed upon!

REFERENCES

NOTES

All entries are headed by the name of one or more persons in **bold type**.

Each entry is in two parts, separated by →.

First part: author; work referred to with original date; edition used with date if different from original.

Second part: the source(s) from which the relevant section of the work was obtained; namely, publisher or journal with date of publication, or another reference. It is noted where only a quotation from the original work appears in the source.

Page numbers in footnotes refer to sources, except as otherwise indicated.

Akins, Kathleen A.: "A Bat without Qualities?", 1993 → **Davies, Martin & Glyn W. Humphreys, eds.:** *Consciousness; Psychological and Philosophical Essays*, 1993

Akins, Kathleen: "Of Sensory Systems and the 'Aboutness' of Mental States", 1996 → (1) *Journal of Philosophy*, Vol. 93(7), pp. 337-372, 1996; (2) **Bechtel, William, *et al.*:** *Philosophy and the Neurosciences*, 2001

Alexander, Peter: "Mach", 1967 → **Edwards, Paul, ed.:** *The Encyclopedia of Philosophy*, Vol. 5, pp. 115-119, 1967

Aristotle: *Metaphysics*, 4th century BC → quoted in **Kirk, G.S., J.E. Raven & M. Schofield:** *The Presocratic Philosophers*, 2nd edn., 1983

Armstrong, D.M.: *A Materialist Theory of the Mind*, 1968; revised edn., 1993 → Routledge, London, 1993

Armstrong, David M., ed.: *Berkeley's Philosophical Writings*, 1965 → Collier–MacMillan, London, 1969

Atkin, Keith: Letter to the editor, 2002 → *New Scientist*, 13 July 2002

Ayer, A.J.: *The Foundations of Empirical Knowledge*, 1940 → MacMillan, London, 1969

Baumgartner, Wilhelm: "Franz Brentano", 1995 → **Honderich, Ted, ed.:** *The Oxford Companion to Philosophy*, pp. 102-104, 1995

Bechtel, William, *et al.*: *Philosophy and the Neurosciences; A Reader*, 2001 → Blackwell, Malden, Massachusetts, 2001

Bell, E.T.: *Men of Mathematics*, 1937 → Simon & Schuster, New York, 1962

Benacerraf, Paul & Hilary Putnam, eds.: *Philosophy of Mathematics; Selected Readings*, 1964; 2nd edn., 1983 → Cambridge University Press, Cambridge, 1996

Berkeley, George: *De Moto*, 1791 → **Armstrong, David M., ed.:** *Berkeley's Philosophical Writings*, 1965

Berthelot, Marcellin: Debate at Institute of France, 1877 → quoted in **Pullman, Bernard:** *The Atom in the History of Human Thought*, 1998

Blakemore, Colin & Susan Greenfield, eds.: *Mindwaves; Thoughts on Intelligence, Identity and Consciousness*, 1987 → Basil Blackwell, Oxford, 1987

Bohm, David: *Causality and Chance in Modern Physics*, 1957; new edn., 1984 → Routledge & Kegan Paul, London, 1984

Brentano, Franz: *Psychology from an Empirical Standpoint*, 1874 → (1) quoted in **Moran, Dermot:** “Brentano’s Thesis”, 1996; (2) quoted in **Baumgartner, Wilhelm:** “Franz Brentano”, 1995

Burnet, John: *Early Greek Philosophy*, 1st edn., 1892; 4th edn., 1930 → A. & C. Black, London, 1930

Burnet, John: *Greek Philosophy, Thales to Plato*, 1914 → MacMillan, London, 1950

Campbell, Keith: *Metaphysics, An Introduction*, 1975 → manuscript of **Campbell, Keith:** *Metaphysics, An Introduction*, 1976

Campbell, Keith: *Metaphysics, An Introduction*, 1976 → Dickenson, 1976

Campbell, Keith: “Selective Realism in the Philosophy of Physics”, 1994 → *The Monist*, Vol. 77, No. 1, pp. 27-46, 1994

Carnap, Rudolf: *An Introduction to the Philosophy of Science*, 1966; Dover edn., 1995 → Dover, New York, 1995

Carnap, Rudolf: “Empiricism, Semantics, and Ontology”, 1956 → **Benacerraf, Paul & Hilary Putnam, eds.:** *Philosophy of Mathematics*, 2nd edn., 1983

Carver, Raymond: *Cathedral*, 1983 → Vintage, 2003

Carver, Raymond: *What We Talk About When We Talk About Love*, 1981 → Vintage, 2003

Churchland, Patricia Smith: *Neurophilosophy; Toward a Unified Science of the Mind–Brain*, 1986 → MIT Press, Cambridge, Massachusetts, 1995

Churchland, Paul, M.: *A Neurocomputational Perspective; The Nature of Mind and the Structure of Science*, 1989 → MIT Press, Cambridge, Massachusetts, 1992

Churchland, Paul, M.: “Reduction, Qualia, and the Direct Introspection of Brain States”, 1985 → **Churchland, Paul, M.:** *A Neurocomputational Perspective*, 1989

Churchland, Paul M.: *Scientific Realism and the Plasticity of Mind*, 1979 → Cambridge University Press, Cambridge, 1990

Coffa, J. Alberto: *The Semantic Tradition from Kant to Carnap; To the Vienna Station*, 1991 → Cambridge University Press, Cambridge, 1993

Coleridge, Samuel Taylor: *Dejection, An Ode*, 1797

Comte, Auguste: *Cours de Philosophie Positive (Course in Positive Philosophy)*, 1830 → **Comte**, **Auguste:** *The Fundamental Priciples of Positive Philosophy*, 1905

Comte, Auguste: *The Fundamental Priciples of the Positive Philosophy*, 1905 → Watts & Co., London, 1905

Crane, Tim: “Intentionality as the Mark of the Mental”, 1998 → **O’Hear, Anthony, ed.:** *Current Issues in the Philosophy of Mind*, pp. 229-251, 1998

Crick, Francis: *The Astonishing Hypothesis; The Scientific Search for the Soul*, 1994 → Touchstone Books, London, 1995

Cushing, James T.: *Philosophical Concepts in Physics*, 1998 → Cambridge University Press, Cambridge, 1998

D’Alembert, Jean le Rond: *Traité de Dynamique*,1743 → quoted in **Nagel, Ernest:** *The Structure of Science*, 1961

Dalton, John: *A New System of Chemical Philosophy*, 1808 → (1) Russell & Allen, Manchester, England, 1808; (2) quoted in **Toulmin, Stephen & June Goodfield:** *The Architecture of Matter*, 1962

Danto, Arthur C.: Foreward to C.L. Hardin, *Color for Philosophers*, 1987 → **Hardin, C.L.:** *Color for Philosophers; Unweaving the Rainbow*, 1988

Davies, Martin & Glyn W. Humphreys, eds.: *Consciousness; Psychological and Philosophical Essays*, 1993 → Blackwell, Oxford, 1993

Davy, Humphry: *Collected Works*, VII, 1839 → quoted in **Knight, David M.:** *Atoms and Elements*, 1967

Dennett, Daniel: *Consciousness Explained*, 1991 → Penguin, London, 1993

Dijksterhuis, E.J.: *The Mechanization of the World Picture*, 1950; trans., 1961 → Oxford University Press, London, 1969

Drake, Stillman: *Galileo*, 1980 → Oxford University Press, Oxford, 1980

Droscher, Vitus B.: *The Magic of the Senses; New Discoveries in Animal Perception*, 1966; trans., 1969 → Panther Books, London, 1971

Edelman, Gerald M.: *Bright Air, Brilliant Fire; On the Matter of the Mind*, 1992 → Basic Books, New York, 1992

Edwards, Paul, ed.: *The Encyclopedia of Philosophy*, 1967 → Macmillan, New York, 1967

Einstein, Albert: “Grundgedanken und Methoden der Relativitätstheorie in ihrer Entwicklung dargestellt”, 1920 → quoted in **Pais, Abraham:** *‘Subtle is the Lord . . .’*, 1982

Einstein, Albert: *Ideas and Opinions*, 1954 → Three Rivers Press, New York, 1982

Einstein, Albert: *Out of My Later Years*, 1950 → Thames & Hudson, London, 1950

Einstein, Albert: “Physics and Reality”, 1936 → **Einstein, Albert:** *Out of My Later Years*, 1950

Einstein, Albert: “Remarks on Bertrand Russell’s Theory of Knowledge”, 1944 → **Einstein, Albert:** *Ideas and Opinions*, 1954

Epicurus: *c.* 300 B.C. → quoted in **Pullman, Bernard:** *The Atom in the History of Human Thought*, 1998

Ewing, A.C.: *The Fundamental Questions of Philosophy*, 1951 → Routledge & Kegan Paul, London, 1964

Farrington, Benjamin: *Greek Science; Its Meaning for Us*, 1944–49 → Penguin, Harmondsworth, England, 1969

Feynman, Richard P.: *The Character of Physical Law*, 1965; with intro., 1992 → Penguin, London, 1992

Frank, Philipp: *Modern Science and Its Philosophy*, 1949 → Harvard University Press, Cambridge, Massachusetts, 1949

Frank, Philipp: "Why Do Scientists and Philosophers So Often Disagree about the Merits of a New Theory?", 1941 → **Frank, Philipp:** *Modern Science and Its Philosophy*, 1949

Friedman, Michael: "Causal Laws and the Foundations of Natural Science", 1992 → **Guyer, Paul, ed.:** *The Cambridge Companion to Kant*, 1992

Giere, Ronald N.: *Explaining Science; A Cognitive Approach*, 1988 → University of Chicago Press, Chicago, 1988

Greenfield, Susan: *The Human Brain; A Guided Tour*, 1997 → Phoenix, London, 1998

Guyer, Paul, ed.: *The Cambridge Companion to Kant*, 1992 → Cambridge University Press, Cambridge, 1999

Hall, A. Rupert: *From Galileo to Newton*, 1963 → Dover, New York, 1981

Hardcastle, Valerie: "The Nature of Pain", 2001 → **Bechtel, William, *et al.*:** *Philosophy and the Neurosciences*, 2001

Hardin, C.L.: *Color for Philosophers; Unweaving the Rainbow*, 1988 → Hackett Publishing Co., Indianapolis, Indiana, 1988

Harré, Rom: *Great Scientific Experiments; Twenty Experiments that Changed Our View of the World*, 1981 → Oxford University Press, Oxford, 1989

Harris, Errol: *Hypothesis and Perception; The Roots of Scientific Method*, 1970 → Allen & Unwin, London, 1970

Hayes, Nicky: *Foundations of Psychology; An Introductory Text*, 1994 → Routledge, London, 1994

Hoffman, Donald D.: *Visual Intelligence; How We Create What We See*, 1998 → W.W. Norton & Co., New York, 1998

Honderich, Ted, ed.: *The Oxford Companion to Philosophy*, 1995 → Oxford University Press, Oxford, 1995

Hooker, C.A.: "Towards a General Theory of Reduction", 1981 → *Dialogue* XX, pp. 38-59, 201-236, 496-529, 1981

Jackson, Frank: "Epiphenomenal Qualia", 1982 → *Philosophical Quarterly*, 32, pp. 127-136, 1982

Jackson, Frank: "What Mary Didn't Know", 1986 → *Journal of Philosophy*, LXXXIII 5, pp. 291-295, May 1986

James, William: *Some Problems of Philosophy; A Beginning of an Introduction to Philosophy*, 1911 → University of Nebraska Press, Lincoln, Nebraska, 1996

Kanizsa, G.: "Quasiperceptual Margins in Homogeneously Stimulated Fields", trans. W. Gerbino, 1955 → **Hoffman, Donald D.:** *Visual Intelligence*, 1998

Kant, Immanuel: *Metaphysical Foundations of Natural Science*, 1797 → quoted in **Friedman, Michael:** "Causal Laws and the Foundations of Natural Science", 1992

Kant, Immanuel: *Opus postumum* → quoted in **Friedman, Michael:** “Causal Laws and the Foundations of Natural Science”, 1992

Kelvin, Lord: “Nineteenth Century Clouds over the Dynamical Theory of Heat and Light”, 1901 → *Philosophical Magazine and Journal of Science,* Series 6, Vol. 2, No. 7, pp. 1-40, July 1901

Kirk, G.S., J.E. Raven & M. Schofield: *The Presocratic Philosophers,* 1st edn., 1957; 2nd edn., 1983 → Cambridge Univerity Press, Cambridge, 1993

Knight, David: *Atoms and Elements; A Study of Theories of Matter in England in the Nineteenth Century,* 1967 → Hutchinson, London, 1967

Kuhn, Thomas S.: *The Structure of Scientific Revolutions,* 1st edn., 1962; 2nd edn., 1970 → University of Chicago Press, Chicago, 1973

Leibniz, G.W.: *Correspondence with Clarke,* 1715-16 → **Parkinson, G.H.R., ed.:** *Leibniz, Philosophical Writings,* 1973

Leibniz, G.W.: *Monadology,* 1714 → **Parkinson, G.H.R., ed.:** *Leibniz, Philosophical Writings,* 1973

Leibniz, G.W.: *New Essays on the Human Understanding,* c. 1704 → **Parkinson, G.H.R., ed.:** *Leibniz Philosophical Writings,* 1973

Llinás, Rudolfo: “‘Mindness’ as a Functional State of the Brain”, 1987 → **Blakemore, Colin & Susan Greenfield, eds.:** *Mindwaves,* 1987

Locke, John: *An Essay Concerning Human Understanding,* 1690; A.C. Fraser edn., 1894 → Dover, New York, 1959

Mayr, Ernst: *What Evolution Is,* 2001 → Phoenix, London, 2002

McGinn, Colin: *The Character of Mind,* 1982 → Oxford University Press, Oxford, 1982

McGinn, Colin: *The Problem of Consciousness; Essays Towards a Resolution,* 1991 → Blackwell, Oxford, 1993

Melzack, Ronald: *The Puzzle of Pain,* 1973 → Penguin, Harmondsworth, England, 1977

Moran, Dermot: “Brentano’s Thesis”, 1996 → *Proceedings of the Aristotelian Society,* Supplementary Vol. 70, pp. 1-27, 1996

Nagel, Ernest: *The Structure of Science; Problems in the Logic of Scientific Explanation,* 1961 → Routledge & Kegan Paul, London, 1968

Nagel, Thomas: *Mortal Questions,* 1979 → Cambridge University Press, Cambridge, 1991

Nagel, Thomas: “What Is It Like To Be a Bat?”, 1974 → **Nagel, Thomas:** *Mortal Questions,* 1979

Newton, Isaac: *Optics,* 4th edn., corrected 1730 → **Thayer, H.S., ed.:** *Newton's Philosophy of Nature,* 1953

Newton, Isaac: *The Mathematical Principles of Natural Philosophy, Scholium,* 1686 → **Thayer, H.S., ed.:** *Newton's Philosophy of Nature,* 1953

Nye, Mary Jo: *Before Big Science; The Pursuit of Modern Chemistry and Physics, 1800-1940,* 1996 → Harvard University Press, Cambridge, Massachusetts, 1999

O'Hear, Anthony, ed.: *Current Issues in the Philosophy of Mind*, Royal Institute of Philosophy Supplement 43, 1998 → Cambridge University Press, Cambridge, 1998

Pais, Abraham: *'Subtle is the Lord . . .'; The Science and the Life of Albert Einstein*, 1982 → Oxford University Press, Oxford, 1983

Parkinson, G.H.R., ed.: *Leibniz, Philosophical Writings*, 1934; revised edn., 1973 → J.M. Dent (Everyman), London, 1973

Penrose, Roger: *The Emperor's New Mind; Concerning Computers, Minds, and the Laws of Physics*, 1989 → Vintage, London, 1990

Popper, Karl: *Objective Knowledge; An Evolutionary Approach*, 1972; revised edn., 1979 → Oxford University Press, Oxford, 1983

Popper, Karl: *Unended Quest; An Intellectual Autobiography*, 1974; new edn., 1992 → Routledge, London, 2002

Pribram, Karl H.: *Languages of the Brain; Experimental Paradoxes and Principles in Neuropsychology*, 1971 → Prentice–Hall, New Jersey, 1971

Price, H.H.: *Perception*, 1932 → Methuen, London, 1932

Pullman, Bernard: *The Atom in the History of Human Thought*, 1998 → Oxford University Press, Oxford, 2001

Putnam, Hilary: "The Question of Realism", 1993 → **Putnam, Hilary:** *Words and Life*, 1994

Putnam, Hilary: *Words and Life*, 1994 → Harvard University Press, Cambridge, Massachusetts, 1994

Putnam, Hilary: *Reason, Truth and History*, 1981 → Cambridge University Press, Cambridge, 1992

Quine, W.V.: *Theories and Things*, 1981 → Harvard University Press, Cambridge, Massachusetts, 1994

Quine, W.V.: "Things and Their Place in Theories", 1981 → **Quine, W.V.:** *Theories and Things*, 1981

Rostovtzeff, M.: *A History of the Ancient World*, Vol. II, *Rome*, 1927 → Oxford University Press, Oxford, 1938

Roth, Gerhard: "The Quest To Find Consciousness", 2004 → *Scientific American Special*, Vol. 14, No. 1 (*The Brain; A Look Inside)*, pp. 32-39, 2004

Russell, Bertrand: *A Critical Exposition of the Philosophy of Leibniz*, 1st edn., 1900; 2nd edn., 1937 → Allen & Unwin, London, 1949

Russell, Bertrand: *An Inquiry into Meaning and Truth*, 1940 → Allen & Unwin, London, 1951

Russell, Bertrand: Introduction to Ludwig Wittgenstein, *Tractatus Logico Philosophicus*, 1922 → **Wittgenstein, Ludwig:** *Tractatus Logico-Philosophicus*, 1921

Sambursky, S.: *The Physical World of Late Antiquity*, 1962 → Routledge & Kegan Paul, London, 1962

Sambursky, S.: *The Physical World of the Greeks*, 1956 → Routledge & Kegan Paul, London, 1956

Searle, John R.: *Consciousness and Language*, 2002 → Cambridge Univerity Press, Cambridge, 2002

Searle, John R.: “How to Study Consciousness Scientifically”, 1998 → **Searle, John R.:** *Consciousness and Language*, 2002

Searle, John R.: *Intentionality; An Essay in the Philosophy of Mind*, 1983 → Cambridge University Press, Cambridge, 1983

Searle, John: “Minds, Brains, and Programs”, 1980 → *Behavioral and Brain Sciences*, Vol. 3, 1980

Sellars, Wilfrid: “Philosophy and the Scientific Image of Man”, 1960 → **Sellars, Wilfrid:** *Science, Perception and Reality*, 1963

Sellars, Wilfrid: *Science, Perception and Reality*, 1963 → Routledge & Kegan Paul, London, 1963

Shoemaker, Sydney: “Qualities and Qualia: What’s in the Mind”, 1990 → **Shoemaker, Sydney:** *The First Person Perspective*¸1996

Shoemaker, Sydney: *The First Person Perspective and Other Essays*, 1996 → Cambridge University Press, Cambridge, 1996

Sklar, Lawrence: *Physics and Chance; Philosophical Issues in the Foundations of Statistical Mechanics*, 1993 → Cambridge University Press, Cambridge, 1995

Thayer H.S., ed.: *Newton’s Philosophy of Nature*, 1953 → Hafner Publishing Co., New York, 1965

Thompson, William R. & Ronald Melzack: “Early Environment”, 1956 → *Scientific American*, Vol. 194, No. 1, pp. 38-42, January 1956

Toulmin, Stephen & June Goodfield: *The Architecture of Matter*, 1962 → Hutchinson, London, 1966

Twardowski, Kasimir: *On the Content and Object of Presentation; A Psychological Investigation*, 1894 → quoted in **Moran, Dermot:** “Brentano’s Thesis”, 1996

Van Melsen, Andrew G.: *From Atomos to Atom; The History of the Concept Atom*, 1952 → Duquesne University Press, Pittsburgh, 1952

Velmans, Max: “A Reflexive Science of Consciousness”, 1993 → *Experimental and Theoretical Studies of Consciousness (Ciba Foundation Symposium 174)*, pp. 81-99, 1993

Wall, Patrick: *Pain; The Science of Suffering*, 1999 → Weidenfeld & Nicolson, London, 1999

Walsh, W.H.: “Immanuel Kant”, 1967 → **Edwards, Paul, ed.:** *The Encyclopedia of Philosophy*, Vol. 4, pp. 305-324, 1967

Whitehead, A.N.: *Science and the Modern World*, 1926 → Cambridge Univerity Press, Cambridge, 1932

Whitrow, G.J.: *Time in History; Views of Time from Prehistory to the Present Day*, 1988 → Oxford University Press, Oxford, 1989

Wilkes, Kathleen V.: “Is Consciousness Important?”, 1984 → *British Journal for the Philosophy of Science*, Vol. 35, pp. 223-243, 1984

Wittgenstein, Ludwig: *Philosophical Investigations*, trans. G.E.M. Anscombe, 1st edn., 1953; 3rd edn., 1967 → Basil Blackwell, Oxford, 1968

Wittgenstein, Ludwig: *Tractatus Logico-Philosophicus*, 1921; trans. D.F. Pears & B.F. McGuiness, 2nd edn., 1971 → Routledge & Kegan Paul, London, 1972

Young, J.Z.: *A Model of the Brain*, 1964 → Oxford University Press, Oxford, 1964