# A science for psychology

There are two aims in the course. One is to gain a command of what it takes to make a philosophical approach to a human practice, unearthing the presuppositions upon which a way of thinking and acting depends. The other is to achieve some mastery of the basic principles of a unified cognitive science. We shall take for granted that both projects are worth undertaking. Philosophy is a long-standing way of taking up a critical attitude to human practices. Cognitive science, in the hybrid form we will develop it in this course, is, one might say, the best shot yet at achieving a genuinely scientific psychology. There have been many such attempts in the past, but all have so far fallen by the wayside for one reason or another. We will pay some attention to the debris of past enthusiasms that litters the path of history. From each false start we can gain a better view of what it would take to get it right eventually.

We begin with an overview of two aspects of our topic, first sketching the way scientific knowledge is produced and presented. Then we turn to examine what is involved in doing philosophy. We shall then be in a position to understand what it is to do philosophy of science, bringing the two disciplines into fruitful conjunction. It will then be an easy step to the constructive phase of the course – coming to a philosophical understanding of what is required for there to be a science of cognition – a genuinely scientific psychology.

## What is the domain of cognitive science?

There is a range of human activities – remembering, deciding, reasoning, classifying, planning and so on – that have traditionally been thought to belong to a group of mental processes, generally falling under the label 'cognition'. We can think of cognitive activities in terms of tasks. We use our cognitive powers and capacities to carry out all sorts of projects, from deciding what to wear to a party to 'keeping tabs' on a bank account. We may use our cognitive powers to solve problems – for example, to find the shortest way home. Tasks can be performed well or ill, carefully or carelessly, correctly or incorrectly, with many intermediate possibilities. Solutions can be more or less adequate, more or less cleverly arrived at, and so on.

The study of these activities, and the standards to which they are taken to conform, is *cognitive psychology,* the descriptive phase of a psychological science. However, what about the explanatory phase? What must be invoked to account for a person's ability to make choices, to do sums and to solve problems? The principal thesis of what has come to be called 'cognitive science' is that there are neural mechanisms by which cognitive tasks are performed.

The course for which this textbook has been written is based on the conviction that cognitive science should cover a broader field than just the neuropsychology of cognition. It is based on the principle that any branch of psychology, be it the study of cognition, emotions, social action or any other aspect of human mental life, is necessarily a hybrid. It must encompass the naturalistic study of psychological phenomena as they are manifested in what people do. It must also include an empirical and theoretical investigation of the neural mechanisms by which people act and think as they do. Both types of research, however different the natures of the phenomena they study, can be carried out in conformity with the standards and methods of *scientific* investigations. We will develop our understanding of the nature of scientific as opposed to other kinds of research by attending to how research is actually conducted in the realm of the natural sciences.

Why should it be necessary to take time out to establish what is needed to make a method of enquiry 'scientific', in the sense that chemistry and physics are scientific? In the not so recent past psychologists slipped into following mistaken or partial interpretations of the natural sciences. This was particularly true in the days of the dominance of behaviorism. We shall follow the rise and fall of behaviorism as a case study. It illustrates very well how mistaken philosophical views on the nature of science can exert a malign influence on the development of a new science. Even now, a good deal of the misleading terminology of behaviorism and the simplistic empiricism of which it was a part survives among the presuppositions of some contemporary psychology. Fortunately, philosophers of science now offer us a much more satisfactory and plausible account of the natural sciences than heretofore. This will be our guide in following the way that a true cognitive science can be developed.

Our studies in this course will begin with a thorough analysis of the natural sciences. This will provide a methodological springboard from which we will build our understanding of the actual and possible achievements of cognitive psychology and its relation to neuroscience. It will also give us the ability to identify and understand some of its current shortcomings and to appreciate the ways we may overcome them in fruitful programs of research. Some of the practical exercises suggested in the text could become contributions to the growth of cognitive psychology itself.

This course is demanding. We shall be dealing with four disciplines: philosophy of science, discursive or naturalistic psychology, cognitive psychology and the modeling of thought by the use of techniques from artificial intelligence. Finally, to complete the progression, some basic brain chemistry, anatomy and physiology will be required to understand how some and only some forms of computer modeling can be fruitful sources of deep theories in cognitive science. Inevitably, none of these disciplines can be studied in real depth, but that does not mean that the aspects selected in this treatment will be superficial. Readings in supplementary specialist textbooks will, therefore, be of great importance. They will be given in detail as our studies progress.

When we carry out cognitive tasks such as calculating or classifying we use systems of symbols, *meaningful* shapes, marks, patterns, real and imaginary, sounds and so on. One major problem, to which we will frequently return, is how to give a plausible account of what it is that makes a mark a meaningful mark. This is the problem of *intentionality*. No serious efforts at creating a cognitive science can pass it by.

There are right and wrong ways of using symbols which are meaningful for us. One useful metaphor for discussing the standards of their correct uses is to think of manipulating them as if we were consciously paying attention to rules and instructions for so doing. A key field of investigation in the philosophy of cognitive science is how to express the norms that are evidently at work in much that we do but that we are not consciously following. If norms are not expressed as explicit rules and conventions how can they be so efficacious? This is the problem of *normativity*. This problem too must be tackled as we try to build a science of cognition.

Among the symbols and symbol systems we use are words, gestures, signs, diagrams, models, drawings and so on. Cognitive psychology must start with studies of activities such as classifying or remembering, as they are performed by people using the symbol systems available to them in their own cultures. A dancer thinks of a routine in the form of a flow of bodily movements. A student remembers the theme of a lecture in the form of words, propositions. A chemist may think about a chemical reaction in the form of a model or picture of the flux and reflux of ions in a solution.

How are these cognitive tasks performed? By the use of organs in the brain and nervous system, 'cerebral tools'. Cognitive science must include an essential neuro-anatomical and neuro-physiological dimension. We must not forget that most of us possess a supplementary kit of prosthetic devices, such as electronic organizers, which can take over some of the functions of the tools we are endowed with naturally. One can use one's brain to remember an appointment, one's hippocampus to find one's way home and so on. However, one can also use a diary for keeping track of personal commitments in time and a map to manage one's movements in space. Nowadays each of these devices is readily available in electronic form. One of the major questions we will be asking is how much can we learn about how the natural tools work from understanding how the artificial ones do their version of the job. This will take us into the field of artificial intelligence and computational models of the mind.

Our first acquaintance with cognitive activities comes very early in life, much earlier we now believe than had hitherto been thought. Under the influence of the recently rediscovered developmental studies of L.S. Vygotsky (1978), we no longer think of ourselves as maturing cognitively as isolated individuals according to some predetermined schedule, step by step. Our cognitive skills have their beginnings in the flow of symbolic activity of ordinary life in co-operative activities with other people, particularly in the family. Vygotsky's importance for cognitive psychology comes from his work in unraveling the complex processes by which the cognitive and practical skills of adults are acquired by infants and young children in social interactions. Higher order cognitive functions, he said, appear first in the relations between people and only later as part of an individual's mental endowment. First of all we think publicly and collectively with the assistance of others. Only later do we get the knack of thinking privately.

## What makes a study program scientific?

In a scientific treatment of some domain, for example the surface of the earth, we make use of a classification system to identify, describe and categorize the main features of geography. We use such categories as 'islands'. 'continents', 'oceans', 'seas', 'estuaries' and so on. In most sciences, intermediate or borderline cases soon appear, and boundary disputes take place. Is Australia a large island or a small continent? Questions like this can never be settled by observation or experiment. It is not a matter of fact until we have settled on how we will use the concept of 'continent'. Adherents of one way of drawing a boundary around the domain of a classificatory concept offer their reasons and their opponents offer theirs. Issues of convenience, consistency and so on are used to bring agreement on a working convention for settling the scope of application of a category.

A scientific treatment of the surface of the earth would be incomplete without an explanation of how the observable features and their patterns of distribution came about. Why does South America seem to fit so snugly into the curve of Africa, if we imagine them juxtaposed? Scientific explanations typically postulate unobservable entities and processes which bring about the geographical features we can observe. In the case of the earth, geologists nowadays invoke the existence of tectonic plates, slowly moving across the semi-liquid magma in the interior of the earth, and carrying the observable features of the surface with them.

How could we possibly know what these plates are like? We cannot observe them as they are in themselves. Beliefs about the unobservable entities and processes that account for observable states of affairs are usually arrived at by the use of powerful, plausible and fruitful analogies. Instead of trying to think about the real but inaccessible deep structures of earth's crust, we think about Wegener's tectonic plates. How we do that? The plates are a model, that is, a pictorial representation of the real structures. We imagine what they are like by drawing an analogy with something we already know. Perhaps Wegener, the man who first proposed the theory of tectonic plates, saw a similarity between the behavior of icefloes grinding against one another as they are driven by currents in the water and tectonic plates grinding against one another as they are driven by the circulation currents of the molten iron that forms the core of the earth.

Thus a complete earth science must be a hybrid of geography, playing the descriptive role, and geology or plate tectonics, playing the explanatory role.

Here we have a simple example of one of the major techniques of theory building in science. This is model making, using analogies with discretion. Understanding the role of models in science leads to an understanding of the main research methods and procedures by means of which human beings, limited in space, time and resources have gained an understanding of the forces of nature. This has enhanced the human capacity to manage and manipulate them. Most philosophers of science now believe that the basis of our understanding of nature is our capacity to create and manipulate analogs and models of those aspects of the material world that interest us.

Giving written or discursive form to the insights we thus acquire, that is, presenting our scientific knowledge in books and articles, is a secondary matter when compared with the primacy of model making.

learning point

### What is science?

**1** A science consists of:

- **a)** An ordered catalog of phenomena.
- **b)** A system of models representing the unobservable mechanisms by which observable phenomena are produced.

**2** A scientist therefore needs to have:

- **a)** A system of concepts for classifying phenomena. These will define types and kinds, and so create a taxonomy.
- **b)** An accepted source of concepts as a means of controling the making of models, representing the unobservable processes by which phenomena are produced.

Ideally the classification system and the repertoire of explanatory models should be linked in a coherent overall system. There are various ways that this can be achieved.

## Philosophy in the context of science

Philosophers try to bring to light and critically examine some, at least, of the presuppositions upon which the effectiveness, intelligibility and so on of human practices depend. This involves making a preliminary distinction between factual presuppositions and presuppositions concerning the relations between concepts. Conceptual presuppositions are evident in the meanings we give to our concepts and the ways that we take them to be interrelated.

The realization of the great importance of this basic distinction has been one of the major philosophical contributions to our ability to interpret the sciences and to our sensitivity in detecting deep-lying fallacies and muddles. We have learned from Wittgenstein how easy it is to fall into treating an issue about concepts or the uses of words as if it were an issue about matters of fact. Is it just a matter of fact that I cannot feel your pain, or is it a matter of how the word 'pain' is to be used in everyday language? If it is a matter of fact, it could have been otherwise. If it is a matter of the uses of words, we ought not even to make sense of the alternative.

Matters of fact are adjudicated by observation and experiment. Nevertheless, conceptual presuppositions are always involved. To rely on observation and experiment we must presuppose that there are no paradoxes, contradictions or other faults in the system of concepts we use to describe our factual discoveries. Philosophical investigations sometimes involve asking how well a factual presupposition of one aspect of a practice fits with one or more conceptual presuppositions of some other aspect. For example, the practice of finding people guilty of breaking the law presupposes that as a matter of fact someone could have done otherwise than he or she did. However, this clashes with the presupposition of much of psychiatric medicine that in fact aberrant social behavior is fully explicable in terms of neurophysiology and genetics.

Matters of the rules for the correct use of words and other symbols are adjudicated by an analysis of meanings. Sometimes such an analysis reveals unnoticed confusions, contradictions and other faults in a seemingly coherent conceptual system. These can be revealed by studying the interrelations among the meanings of the words that are the verbal expression of a conceptual system. For example, if it is a matter of the meanings of words that people are active agents purposefully finding their way through the problems of living, how can that be reconciled with the use of the concept of unconscious wishes driving a person to behave in ways that are contrary to a long-standing pattern of life?

This kind of critical analysis of large-scale conceptual systems often involves making connections with presuppositions of adjoining practices. For instance, legal philosophy and medical ethics involve cross-connections and comparisons between medical and legal uses of what seem to be the same concepts. In both practices, important parts are played by concepts such as 'death', 'madness' and so on. The *concepts* of 'life' and 'death' have changed in recent years, and this has had its effect on how the law interprets such controversial practices as abortion and euthanasia. To illustrate the fundamental distinction between the two main kinds of presuppositions let us examine a simple, everyday practice. What is presupposed in ordinary commercial transactions where money is used in exchange for goods and services?

An elderly philosopher approaches the ticket office at Jefferson's mansion at Monticello. The clerk says, 'The entrance tickets cost $20.' The philosopher proffers $15 and his Golden Age card. He receives an entrance ticket. What has been presupposed in this not untypical human practice? First of all, here are some *factual presuppositions*:

**1** Hidden from view there is a mansion.

**2** There was such a person as Thomas Jefferson, who ordered the construction of the mansion in accordance with his plans.

**3** There is a discount for senior citizens.
**4** The philosopher is a senior citizen and the Golden Age card is his.
**5** This is Monticello, Charlottesville, Virginia.
**6** The dollar is the local unit of currency.

Here are some *conceptual or philosophical presuppositions*:

**1** Dollars are fungible, that is, the $5 bills the philosopher received in change elsewhere are still, in this new context, worth $5. It would not make sense for the philosopher to ask the cashier, 'Which $5 do you want?'
**2** The mansion, being a material thing, will still be there when the visitor has ascended the hill.

Since the philosophical presuppositions do not involve matters of fact, they can be brought into question only by discussion and analysis. For example, one could get into a discussion about the concept of 'money'. The concept has changed since the days when Hamilton settled on the Maria Theresa thalers, the original silver dollars, as the federal unit of currency. Now dollars are more often than not electronic somethings in cyberspace. Our visitor could have paid by debit card. One could get into a discussion about the concept of a material object. For example, is the mansion that is eventually visited by the philosopher the same mansion that is being visited by each person in the group, if, as some philosophers have maintained, the mansion exists for each visitor only as patterns of colored patches in their personal and private visual fields?

Philosophy of science is a study of the non-factual presuppositions of the practices of the natural and the human sciences. In short, it is a study of the systems of concepts that are put to work in scientific research and theorizing.

## Some other terms for presuppositions

Thomas Reid (1788), writing towards the end of the eighteenth century, called the presuppositions of the human way of life 'the principles of common sense'. By 'common sense' he did not mean everyday wisdom but rather principles that formed a shared background for everyone capable of rational thought.

In the same period Immanuel Kant (1787) coined the phrase 'synthetic *a priori* propositions' to identify the working presuppositions of perception, thought and action. He meant by this to draw attention to the fact that, as he thought, we did not arrive at these principles by the analysis of our experiences. Rather they were what made orderly experience possible. By calling them *a priori* he wanted to emphasize that they were *not arrived at from experience*. By calling them *synthetic* he wanted to emphasize their role in the processes by which our minds synthesize the raw data of the senses into the material world as we know it and, at the same time, into our thoughts about that world. Somehow each person comes into the world equipped with the same basic system of schemata. Though we perform our syntheses of sensations individually to reciprocally create our worlds and our minds, the worlds we create are more or less the same.

In modern times Wittgenstein (1953) expressed the same general idea in his image of the frame and the picture. Our systems of concepts form the frame in which we paint pictures of the world. The frame is not part of the picture. An even more striking and apposite image was his way of referring to the rules for the correct use of words as a 'grammar', extending the idea of correctness beyond the bounds of our ordinary school grammars of nouns, verbs, adjectives and the like. Throughout this course we will use the word 'grammar' for the systems of concepts and their symbolic bearers by means of which we categorize and make sense of our experiences. A grammar, then, can be expressed as *an open set of malleable rules for using various symbol systems correctly.* From time to time old grammars are dropped or modified, and new grammars grow up. Our typewriting concepts have given way to a completely new grammar for managing computing and cyberspace communication.

These three ways of describing some important aspects of the presuppositions of human practices draw our attention to three aspects of the background to what we think, feel and do. It is shared. It is involved in shaping what we experience. It maintains local standards of correctness.

learning point

## What is philosophy?

**1** The project of philosophy is to bring to light and critically discuss the presuppositions of human practices, for instance the law, music and the sciences, even sports. Presuppositions are of two kinds:

- **a)** *Factual*, which can be tested by observation and experiment.
- **b)** *Conceptual*, which can be tested only by discussion as to their plausibility, utility and coherence.

**2** Three ways of presenting the nature of conceptual presuppositions:

- **a)** *Thomas Reid*. Principles of common sense: shared by all, used to make sense of experience.
- **b)** *Immanuel Kant*. Synthetic *a priori* propositions: express the schemata by which we synthesize an orderly world and tidy minds (synthetic). They are not learned from experience (*a priori*). The list of synthetic *a priori* propositions is limited and fixed.
- **c)** *Ludwig Wittgenstein*. Grammars: rules for the correct use of symbols. Grammars can change, usually at different rates under various circumstances.

## Ontology: presuppositions as to what there is

Scientific realists feel free to speculate in disciplined ways about the state of the world beyond the limits of perception. To do so rationally they must have in mind certain ideas about what kinds of things, properties, processes, qualities and so on the world may contain. A catalog of what is taken to be really real in some domain of enquiry is its *ontology*. This takes us back to the discussion of presuppositions. An ontology will be among the presuppositions of a science at each moment in its development. Therefore philosophy of science must include discussions of ontology, the general assumptions about the presumed nature of the entities, structures, properties and processes both observable and unobservable characteristic of the relevant domain of enquiry.

## Two versions of a materialist ontology

For four centuries the natural sciences have balanced uneasily between two major and very different materialist ontologies. Their indirect influence on psychology has been profound. We must pause to look at them rather closely.

*Atomists* imagined the world to be a swarm of solid, material particles, moving randomly in an empty void, occasionally making contact by colliding with one another. When not in immediate contact these fundamental bodies were thought to behave quite independently of one another. Atomic particles were passive except in so far as they were in motion. Gravity, magnetism and electricity posed great difficulties for mechanical atomism, since each of these types of interaction seemed to work without a material link from body to body. The attempts by such scientific geniuses as Isaac Newton to accommodate action at a distance, as it was called, into the atomistic ontology were ingenious but ultimately unconvincing. The force of gravity remained a great mystery for Newton and his successors. They could describe how it manifested itself, but its real nature remained quite unknown. A universal medium, the ether, was postulated to explain all non-mechanical phenomena, even the processes of thought.

*Dynamism* expressed an opposite standpoint in almost every respect. Everything was actively involved with everything else. Space was filled with fields of force: described in terms of potentials for action at every point, ready to bring about effects whenever some suitably sensitive test body was brought under their influences. The phenomena of magnetism, the study of which had begun in the sixteenth century by William Gilbert, were taken up again by another scientific genius in the nineteenth century with a radically different ontology from that of the atomists. In the work of Michael Faraday we have the beginnings of the modern ideas of forces, charges and fields, typical dynamicist concepts, defining an interlinked world of active beings.

While the adoption of atomism by the physicists of the seventeenth century opened up a wealth of research possibilities, it eventually became a burden, since it required all action to be mediated by direct contact between material corpuscles. The shift to dynamicist ideas, allowing natural scientists to picture a world of active beings interacting with one another across the whole of time and space, ushered in the modern era. Instead of atoms wandering in the void, we now have charges and fields interacting through the whole universe.

**Table 1.1** Atomism versus dynamism

| | Atomism | | Dynamism |
|---|---|---|---|
| **1** | Multitude of beings in a void, or empty space. (Newtonian mechanics) | **1** | Multitude of centers, but influence occupies the whole of space. (Charges and fields) |
| **2** | React only when in actual contact | **2** | In continuous interaction even at a distance |
| **3** | Logically independent: deleting one does not affect others. (Selling one sheep from a large flock does not affect the remainder) | **3** | Logically dependent. (All members of a soccer team affected when one player sent off) |
| **4** | Atoms are passive: react only when acted upon | **4** | Dynamic entities are active: act unless action blocked |
| **5** | Generally deterministic: future and past both actual. Possibilities not real. Properties occurrent | **5** | Generally indeterminstic: past actual but future open. Possibilities real. Properties dispositional |

We can appreciate the contrasts between these points of view most easily in a comparative table setting out their main characteristics (Table 1.1). Which ontology shall we take as our model in setting up psychology? Behaviorism was not only positivistic but also tended to treat human beings as the passive sites of responses to stimuli, much as the atomists of the seventeenth century had thought of material particles as responding to action only by contact with another such particle. Moreover, there was a tendency to divide stimulus conditions and responses into atom-like units, the independent and dependent variables of behaviorist psychology. However, in our era, one can chart the growing influence in psychology of dynamicist ideas. One can see psychologists taking up and developing the idea of people as agents, actively trying to realize their projects, plans and intentions, rather than simply passively responding in well conditioned ways to environmental stimuli.

## Ontological presuppositions in psychology

The breadth and depth of these contrasting ontologies suggest that there are better and worse general conceptions of the nature of the world and of the domain of each science at each stage of the development of the sciences. The history of science illustrates very clearly that assessments of the ultimate value of this or that ontology may not be wise until it has been tried out in many ways and in many contexts. We can judge a set of foundational principles only in the long run and by hindsight. ‘Doing justice to our life experiences’ in a manner that is recognizably scientific is what we want from a successful cognitive science.

How is that worthy sentiment to be given teeth? It will not be achieved without careful attention to the ontology implicit in our attempts to realize our scientific ambitions. We will find that the domain of psychology includes not one but two ontologies, neither reducible to the other. One of the great achievements of theoretical psychology in recent years has been to offer a sketch of how unification is to be achieved. The two ontologies that seem at first sight to be rivals are *mentalism,* the view that the domain of psychology ought to be confined to thoughts, feelings and meaningful actions, and *materialism*, the view that the domain of psychology ought to be confined to material states of the body, in particular of the brain and nervous system.

**learning point** **Ontology**

Presuppositions about what there is in the domain of a science. Two major variants:

1 *Classical atomism*. Logically independent passive Newtonian particles in the void, defined by occurrent properties, acting only by contact, in a deterministic closed future.
2 *Modern dynamism*. Logically dependent agents in continuous interaction, in an open future, defined by dispositional properties, for example charges and fields.

In psychology many of the leading ideas of classical atomism reappeared in behaviorism. In treating people as active agents we see the beginnings of a dynamical point of view in psychology.

## Science, philosophy and psychology in history

The project of creating a scientific psychology has made several false starts. The first of the modern attempts to create such a psychology must surely have been the efforts in the seventeenth century to study the world of ideas in the same manner as the physicists of the era were studying the world of matter. Most of the issues that have troubled contemporary efforts to create a scientific psychology, beginning with Wundt's laboratory for psychophysics in the nineteenth century, were already well understood in the seventeenth and were discussed in depth in the eighteenth. In this book we shall be looking at the most recent attempt to achieve the laudable aim of a science of cognition. It will be necessary to survey some of the older and unsatisfactory attempts in order to get a feel for the problems that have led to so many failures to create a scientific psychology that can stand alongside physics and chemistry, the sciences of material things and substances. There are excellent histories of psychology in which the story of the psychologies of the post-Renaissance era can be followed in greater detail. Our task will be to understand, in the light of some significant past failures, the most recent and the most promising start yet.

Psychologists neglect philosophy at their peril. The interplay between philosophy and psychology will be as much a feature of twenty-first-century psychology as it has been part of the formation of all the sciences since the days of Aristotle. However, the penetration of science by philosophy, evident as it is in physics no less than in psychology, has to be viewed critically. The insidious effect of positivism is perhaps the most striking example of the kind of psychology that has proven to be so disappointing as a pointer to a future science. To get the presuppositions of the natural sciences wrong was indeed a terrible legacy of the positivistic era in philosophy. The positivist/realist distinction will occupy us in Chapter 2.

## The project of a scientific psychology in full

Inevitably, psychology will be a hybrid science. This was foretold by Wilhelm Wundt a century and a half ago. Naturalistic studies of ordinary ways of thinking that make use of language and other symbolic systems will give us an insight into the culturally and historically diverse phenomena of thinking, acting and feeling. Neurological studies will give us insights into the cerebral tools we use to accomplish the cognitive tasks contemporary life presents us with. How do we bridge the gap between naturalistic studies of meaningful actions by active people and neurological research programs studying material processes, so that the latter are relevant to the former? We need some technique by which we can abstract important patterns from the concrete reality of everyday cognitive processes and phenomena. Such a technique must also allow the abstract processes so discerned to be given a concrete interpretation in neurological terms. The answer is to be found in developments in artificial intelligence, with the help of which we can build effective and abstract models of the *possible* mechanisms of cognition, based on abstract models of processes of cognition.

We shall be treating the project of developing a scientific psychology as a progression through four stages, each of which depends on successful undertakings in that which precedes it.

**1** To record, analyse and understand the public and private processes and procedures by which competent people use the available symbolic resources and techniques to accomplish cognitive tasks. We shall be alert to identify the standards by which such tasks are assessed, formally and informally in different cultures (Cole, 1996).

**2** To develop abstract analytical or descriptive models of the ways people accomplish these tasks, based on abstractions from the task descriptions themselves. Such 'models of mental processes' have no existential implications. They are pragmatically helpful ways of presenting what we know of the phenomena in question (Baddeley, 1998).

**3** To develop abstract artificial intelligence models of the processes that may be involved in actually performing the cognitive and practical tasks described in the first stage of a research program (Copeland, 1998).

**4** To use the models developed in Stage 3 to control neuroscience research programs on the look out for cellular structures as real analogs of the abstract structures presented in good working artificial intelligence models (McLeod et al., 1998).

In the successful accomplishment of such a program for at least some of the major cognitive skills displayed by human beings we will have finally overcome the legacy of behaviorism and broken the ties with the positivist myth.

## Conclusion

A scientific research program comprises two main projects. There must be a way of identifying and classifying the phenomena to be studied. There must also be a way of thinking about the processes by which those phenomena come into being, and so explaining them. The classifying job needs a system of categories and kinds, expressed in the concepts of a taxonomy. The explaining job needs a picture or model of the mechanisms involved. At the beginning of a research project the real mechanisms cannot usually be observed. As the project unfolds methods of extending the resources of experimental and observational techniques into previously hidden regions of the world are developed.

Much is presupposed in the initiation and development of research programs. Philosophers specialize in bringing at least some of the presuppositions of human practices to light. These fall into two main groups. There are factual presuppositions, which can be tested like any factual claims. There are also conceptual presuppositions, expressing the way the components of conceptual systems are interrelated. Conceptual presuppositions can be examined for consistency, plausibility and so on. It is important to realize that there is no hard-and-fast line to be drawn between factual and conceptual presuppositions. Any particular proposition may drift from one category to the other as our knowledge and techniques of enquiry change and develop.

Framing the whole of a program of scientific research are ontological presuppositions, presumptions as to what sorts of beings there are in the domain of research. The history of science discloses two main ways in which the beings of the material world have been taken to be. The atomistic ontology is based on the principle that the material world consists of a swarm of minute material particles. They interact only when they come into contact. The only source of activity is motion. The dynamicist ontology is based on the principle that the material world is a field of continuously interacting centers of activity. Each such center is an active agent, exerting its influence on all around it. Newtonian mechanics is the scientific basis of the atomistic ontology. The physics of electromagentism of Faraday is the scientific basis of the dynamicist ontology.

The study of thinking, feeling, perceiving and acting, the field of the human sciences, must take account of the mental lives of human beings. They seem to involve non-material phenomena. Yet human beings are embodied, living in a material world of causal processes. Focusing only on the immaterial aspects of human experience leads to mentalism, while focusing only on bodily processes leads to materialism. The aim of this course is show how it is possible to unify the two main trends in contemporary, twenty-first-century psychology, to create a scientific psychology powerful enough to include minds and bodies in a common research program.