CHAPTER 8

Conclusion

We have problematized, clarified and illustrated, but not resolved as such. This is hardly surprising, for the former represent those themes that, we argued, are part of the positive relationship that can exist between social research and philosophy. From this point of view, one cannot expect philosophical discourse to represent a final court of appeal. As we noted in Chapter 1, we find illumination in examining science from a philosophical point of view, but not all philosophical problems are translated into scientific questions. Similarly, while social research yields systematic information on the social world, the question as to what to do with this information, in terms of its application, becomes a matter for societal values and political relations. However, that is not to suggest that the practice of science and social research is separate from such issues—this much has been clear from our prior discussions.

In terms of the positive potential of this relationship, we deliberately started with the taken-for-granted question, "what is science?". Once placed under the philosophical microscope, we saw how and why it may be claimed that particular work is characterized as "scientific". At this point, we entered the realms of ontology and epistemology. These were expressed in terms of the grounds for knowing what things exist in the social and natural worlds and what properties they possess. Here we found two traditions that approached these questions, both of which had consequences for the conduct and nature of scientific endeavour. These were the traditions of empiricism, as exemplified in the work of Hume and the tradition of rationalism, as found in the work of Descartes. An attempted fusion between these two approaches then occurred in the work of Kant.

These abstract debates appear, on first glance, to be far removed from the daily business of science. Yet when we begin to consider the search for *a* method that would prove to be *the* unifying factor in the process of scientific discovery, we can see how they relate directly to scientific endeavours. Empiricism, for example, grounds its basis of knowledge in experience as derived through the senses. This, in turn, may be translated into induction as a characteristic of scientific procedure where everything rests upon specific observations from which are derived general principles concerning the uniformity of nature. In the work of Kant, however, his critique of empiricism and fusion with rationalism, leads to the insight that the material world may cause our sensations, but it is our mental apparatus that then orders these stimuli. The mind thus provides the concepts through which people understand and explain their experiences.

The implications of this latter position were then traced in the following manner. The object world, with which empiricism is concerned, does not have an existence that is independent of our thoughts. The point is that if we are to come to have reliable and valid knowledge concerning the natural or social worlds, then it rests upon the exercise of reason as a universal capacity of the human mind. At this point, we noted that Kant differentiated between synthetic and analytic statements. The latter were found to rely upon deductive logic whereby the truth of a conclusion is contained within the premisses of an argument. This philosophical abstract notion then fed into the idea of science proceeding upon the basis of deductive, not inductive logic, with attention to the instruments with which we measure the social and natural worlds becoming paramount.

The logical positivists took these ideas on board, yet with the empiricist implication that science should reflect the world as it appears to us and cannot, with any legitimacy, get at what the world is beyond that appearance. All other endeavour was thereby reduced to metaphysical speculation. Karl Popper, once associated with the "Vienna Circle", found these conclusions to be too harsh and contrary to the procedures of deduction. After all, they not only ruled out the realm of metaphysics, but also that of theory. The simple separation, held by the logical positivists, between a language that describes reality and the conceptual language which is then used to explain that reality, does not hold. The idea of verification as a characteristic of science, in this tradition, must be predicated upon a separation of these two languages. According to Popper, however, this was not possible. Given this, he maintained that theories can never be proved correct, and that science must be open to the idea of

falsifying them according to a rigorous set of tests and procedures. Science was now characterized as the systematic search for "disconfirming instances" of particular theories, which themselves must be open to falsification. In other words, the elimination of untruth is said to lead us closer to the truth.

Popper's work also allowed for the role of subjective criteria in the formulation of theory. This may be taken a step further to say that not only the theories, but also the procedures of science, have a central social dimension to their practice. Science, therefore, is not a disembodied activity whose practitioners float freely over the social and natural landscapes unfettered by the context of their work. Kuhn thus examined the actual practice of science in terms of what he called "paradigms". Assumptions were found to be held to be true within a hermetically sealed scientific community. These standards set what was to constitute "normal" science; until, that is, a revolution in thought took place that directly challenged these assumptions. Science may now be characterized, as it has been by a particular group of sociologists of science, as a process informed by social and psychological factors. This perspective, informed by empirical studies of science, may lead us to conclude that there is no systematic difference between the social and natural sciences in terms of the methods, procedures and theories that they generate and employ. Given this potential end point to Chapter 2, it became of importance to consider the status of the social sciences. Do they, or should they, reflect the same methods as used in the physical sciences, or are they different from, but not inferior to, these sciences? We examined these questions in Chapter 3.

From an historical viewpoint, it was perhaps inevitable that the social sciences should attempt to replicate the methods of the natural sciences; evolving as they did in their shadow. The positivism of those such as Comte, Durkheim and Mill certainly represented this position, where the differing subject matter of the disciplines was said to have no relation to the search for a unity of method. The assumptions of this position were that we may justifiably study social life by examining the "external regularities" of human behaviour. This then follows the natural scientific model that explains an event by considering it as *"the effect of a cause"* (Strasser 1985:2. Original italics). This approach, however, left us with problems. After all, human meaning and consciousness are central features of the social world; hence, there is an ontological distinction to be made with the natural world. As such, some reference to the "inner mental

states" of human beings is required in order to understand, as opposed to explain, social relations. This process involves, "understanding what makes someone tick" or how they "feel or act as a human being" (Taylor 1981:30).

This latter observation took us in the direction of what we characterized as interpretivist approaches to the study of social life. These took several forms from hermeneutics, via a Weberian synthesis of explanation and understanding, through to phenomenology. For instance, in Dilthey's neo-Kantian move, he argued that we cannot know the world in itself, but we can come to know the human consciousness that represents that world. Following Hegel, this world could be known through what was termed the objective mind which, as part of the history into which we are all born, enables us both to understand our environments and to act within them. The implication is that we should seek to understand the social world from the "inside", not explain it from the "outside" by reference to natural scientific models of cause and effect.

Weber then emerged as something of an iconoclast in his fusion of causality and meaning. The social sciences should seek to understand social action while explaining it in terms of the relations of cause and effect. Did this synthesis, within the tradition of German idealism, hold? Not so from the perspective of phenomenology. This tradition was represented by the work of Husserl and following him, the sociological phenomenology of Schutz. Here we return to the idea of social reality being constituted by human consciousness. On this occasion, however, it was manifest in the idea that people, in a taken-for-granted manner, draw upon a "natural attitude" in everyday life. In Schutz's work this became a pre-reflexive world which is constituted of common sense ideas that enable us to attribute meaning to, and communicate within, the social environments that we inhabit. In order to achieve validity, therefore, the theories of the social sciences must reflect this stock of common sense knowledge if it is accurately to reflect everyday life. The practice of social science must then obey what Schutz (1979) called the "postulate of subjective adequacy": that is, there should not be a disjuncture between the social scientific and everyday world of "theorizing".

Phenomenology was also to take a more ontologically inspired course that was to be found in the work of Heidegger. This involved a critique of Kant in that he did not attempt to "solve" the relationship between a perceiving subject and an object world, because he moved the whole question of human existence to an examination of "being-in-time". This

ontological basis found its outlet in the works of Gadamer who argues that a text may be read as indicative of a particular epoch. Similarly, Ricoeur, in seeking a bridge between the traditions of explanation and interpretation, argues that whereas intentionality may be present in speech, it is not present in a text whose existence is as a power for the purpose of disclosing something about a particular world to the reader via the act of appropriation (Ricoeur 1982). Hermeneutics had moved us away from a unidirectional preoccupation with method, as in the concept of *verstehen,* to being indicative of a general way of life. At this level, the implications for social research lie in terms of "belonging" to a social world and "encountering" a world that may be alien to the researcher.

The general trend up to this point was a move away from a correspondence towards a coherence theory of truth. Nevertheless, we were still left with a central issue in the interpretivist tradition, that is, if the understanding of human meaning is a goal of social investigation, then how can we know other minds? It thus became necessary to examine this and other questions posed in Chapter 3 by considering particular views on social reality, together with the strategies that researchers adopt in generating their knowledge about the social world. This was a division between ontological and epistemological positions that we made for the purposes of enhancing an understanding of these important debates. Yet it was, as we noted in Chapter 4, one that ultimately collapses.

We divided ontological claims regarding social reality into two broad camps: those of the idealists and the realists. The former hold social reality to be mind dependent, while the latter consider social reality to consist of real phenomena that are not simply reducible to acts of perception. The adoption of one or other of these perspectives clearly had implications for the methodological strategies thought appropriate for the discovery of social phenomena. For instance, working within the traditions of neo-Kantian idealism, Weber's methodology involved the use of "ideal types". These serve as heuristic devices predicated upon the idea that we can never come to know reality itself, but instead must sharpen the instruments through which we observe it. This, in turn, required a degree of congruence between the concepts used by the investigator and those of the investigated, given that social science was concerned with the constitution of meaningful behaviour. The route taken for this purpose was to employ notions of the rationality of social action in order, to link to our earlier discussion, that cause and meaning were both appropriate to the conduct of social science.

You will recall that for Schutz the imposition of scientific models of social reality onto everyday life leads to reification of social phenomena and hence a resultant reduction in accurate representation. This critique had some parallels with the linguistic turn in social investigation insofar as meanings in everyday life became a topic, rather than a resource, for the social sciences. The important difference here, however, was that any reference to inner consciousness—one of the problematics with which we left Chapter 3—was no longer required for the process of social investigation. Instead, we should focus upon publicly available language games, themselves indicative of forms of life, where the concept of a "private language" became redundant. In other words, we needed to expunge what some who work within this tradition of ordinary language philosophy have called the "phenomenological residua" in social thought (Coulter 1979).

An influential translation of Wittgenstein's ideas on language games, which overlooks the centrality of praxis in his work (see Rubinstein 1981), was to enter the social sciences via the work of Peter Winch. Now, if we accept that social reality is dependent upon language for its constitution, then we might look to the rules of language through which people attribute meanings to situations, activities and utterances in everyday life. These same rules would then also apply to the societies of which they are a part. Therefore, we not only jettison the need to refer to inner consciousness in our studies of social relations, but also the applicability of cause and effect to its study. Furthermore, in order to understand forms of life it is necessary to do so from the "inside", only this time through reference to language use.

Despite the considerable criticisms of Winch's ideas—in particular, that they were relativistic and still required notions of truth and falsehood in the study of language—this linguistic movement found its outlet in the work of the ethnomethodologists. Together with the work of Schutz and Parsons as their intellectual antecedents, the focus of social inquiry was to move from questions of why to those of how. In other words, to take the topic of social science as the everyday methods through which people produce social reality. Here we witnessed the jettisoning of epistemological and ontological concerns, to the adoption of a methodological strategy for understanding the social world.

Questions still remained in this empiricist programme of social investigation. These revolved around the exact relationship between language games and the role of the interpreter. More specifically, how do

ethnomethodological analysts apparently float free from their own language games in order to interpret those of others? To explicate this process would require a resort to the concept of a hermeneutic encounter between different cultures. This is a notion that is conspicuous by its absence in a tradition where relativism, if not always explicitly celebrated, is implied in its procedures for the uncovering of the practical structures of everyday actions. Furthermore, as Winch (1990) notes in his more recent reflections, the idea of the applicability of cause will not simply disappear from the study of social life. Indeed its meaning is clearly more broad than his earlier work, which drew rather narrowly upon the legacy of Mill, had allowed for. This is where realism made its entry into our accounts on the study of social phenomena.

For our purposes, one of the central tenets of realism is the proposition that although there is a clear relationship between the development of scientific knowledge and the objects that it describes, the latter are regarded as "existentially intransitive" (Bhaskar 1994:549) in order that, *a priori,* any form of scientific investigation can take place. As such, it becomes necessary to posit the existence of a world that is, to some degree, independent of human consciousness in order to justify the title "scientific". It follows that to study the social world simply in terms of intersubjective meaning production is highly limited. Social science should now also concern itself with those structures that underpin our actions and may exist independently of our perception of them.

Given the problems of identifying necessary and sufficient conditions in open systems, realists employ the notion of "tendencies". A sophisticated methodology was thus required so that a link might be established between the intransitive objects of social reality and the transitive objects that exist within social science. However, whereas realists were naturalists, they were not reductionists. With this in mind we found ontology driving their ideas and, given that the social world is constituted by the actions and meanings of people, social structures are not viewed as simply existing independently of those actions. Given this, structures are seen to produce people, as well as being reproduced by their actions. This "transformative capacity" was found to be represented not only in the work of Bhaskar but also, to some degree, within the social theory of Anthony Giddens.

An empiricist might object to the above insofar as structures are not directly available to the senses. Instead, for realists, they are an object of explanation, not empirical examination as such. However, we noted earlier

that Popper was critical of the logical positivists on the grounds that they believed reality and descriptions of reality possess some strict demarcation point. This opens up questions regarding the strategic consequences of critical rationalism, our next port of call, for scientific study. Two issues, in particular, were of importance at this stage. First, the limitations of falsification as a characteristic of scientific procedure and secondly, the consequences of the entry of social and psychological criteria into the scientific process. These were found to be linked.

Lakatos noted that, from a strategic point of view, scientists will hold onto the central theoretical elements of their research programmes. Around these sit what might be characterized as satellite hypotheses that are subject to falsification, rejection or modification. As long as this provides novel insights, programmes are maintained. On occasion, however, even the core theoretical elements will be damaged by scientific discoveries. Now, while this provides a corrective to naïve falsificationism and allows for the role of social factors in scientific work, Lakatos's concerns were entirely with the physical sciences. The hard core of Marxism, for example, is more difficult to disprove on these terms quite simply because it contains a scientific element, and also informs praxis: that is, practical conscious activity. Therefore, as long as it appears to make sense of society for particular groups of people and informs their actions, it cannot be simply "falsified". Ironically, there exists a degree of idealism in what many regard as this materialist theory that scientific "tests" will neither capture, nor refute.

One way round this in the practice of science is not to get preoccupied with the appropriateness of tests for concepts, but instead link them directly into concerns of operationalization. The result is a correspondence between a concept and measure, where the latter is seen as constitutive of the former. Concepts require empirical indicators and these are operationalized to produce a series of measurements, for example, the proposition that, "IQ is what IQ tests measure". However, we are back to the problems we have encountered before. As Rom Harré noted, this is a positivist programme whereby the only permitted objects in science are those that are observable. This is problematic also because it says nothing of the relationship between the observer and the observed. In addition, given the number of concepts which surround our ideas of, say, class, this strategy cannot render justice to these given the instrumentality of the approach.

We were then left with three more ways in which we might seek to understand the process of science from the point of view of strategic

knowledge production. They were: probability theory, network theory and pragmatism. Probability was noted to be the opposite of critical rationalism insofar as it was inductive. It becomes the suspension of cause in favour of statistical inference. Expressed in these terms we find an enormous amount of market and social science research proceeding on this very basis. Here we found a distinction to be made between objective and subjective probability. The first operated more in terms of closed than open systems that, as we have argued, characterize the social world. In terms of the latter, Bayesian theory sought to account for social life as an iterative process whereby we learn from our environment and adjust our behaviours accordingly. While this allows for the social dimension of knowledge accumulation, a difficulty remains in terms of identifying, *a priori,* the relationship between new and prior knowledge in order to understand this process.

Probability theory was then found to be associated with network theory in terms of the relationship between classes. Network theory, in the Duhem-Quine thesis, holds that scientific theories form an interconnected web. From this it followed that we could not be sure that it was our entire background thinking that was not being falsified, according to Popperian ideas, by our scientific tests. This allows, once again, the entry of a particular group of sociologists of science onto the terrain of explaining scientific strategy. The theoretical language that describes reality now became a centre of inquiry. This language is formed within a social network that has a self-referential character. Given this, it does not refer to a set of external conditions, as maintained by the correspondence view of truth, but on the contrary, to the network of which it is a part. We thus travel back to coherence theory as a characteristic of scientific endeavour. However, it does not follow from this that all theories may be considered as possessing equal validity. To consider this question we might propose, for example, that all utterances pre-suppose a particular claim to validity. As such, claims to validity might be settled within a scientific community whose ideal is that of "truth-seeking". This is where pragmatism entered our considerations.

In the pragmatist tradition, which we chose to present as one characterization of scientific procedure, we noted a rejection of the subject-object dichotomy in social and philosophical thought. In its place, we find an adaption to the environment accompanied by the production of meanings that orientate our conduct. Now, within this tradition, the possibility existed for the focus of inquiry on meaning production to exceed that of truth-seeking as an ideal that orientates the conduct of

scientists. This is where James stepped in, to view knowledge production as the satisfaction of indigenous needs and interests. Knowledge production thereby became judged by its "usefulness", rather than its "truth". We found this leading to an instrumentalism to which Peirce reacted, referring to his work as 'pragmaticism' in order to differentiate it from such formulations.

From the discussion in Chapter 4 we concluded that the social dimension to scientific knowledge production would not leave our picture. If we accept this link, the questions are begged as to what extent such work might be considered "objective". This, as we noted, is usually defined in terms of science being a value-free enterprise. However, what if we reversed this taken-for-granted notion and posit, instead, that valid social science is only produced through being informed by values? It was arguments around this issue that we sought to illuminate in Chapter 5 where our first step was the clarification of what is often called the "is-ought" question or, as we expressed it, the relationship between facts and values. For clarity of exposition, we then translated this into four positions that exist within the social science literature. Once again, our aim was not to exhaust what is a considerable body of literature, but to illustrate the ways in which social scientists have approached this important issue.

Our first stop, perhaps not surprisingly given the history of the social sciences, was to examine the positivist approach. Durkheim's holist and structuralist approach to the study of society, in contrast to atomism, permitted an objectivity at the level of the study of aggregate social phenomena. However, the very naming that is part of the process of classifying social phenomena is a normative act. Weber, on the other hand, noted the existence of social values in the determination of ends. Yet it did not follow from this observation that the social sciences could not be value-free endeavours for we cannot deduce an "ought" from an "is". Social science, therefore, cannot, "partake of the contemplation of sages and philosophers about the meaning of the universe" (Weber in Gerth & Mills 1948:152). The division of labour between social science and philosophy, in terms of the separation between means and ends, was clear. Nevertheless, we argued that the contemporary resonance of Weber's writings actually derive from their being informed by values. From this observation we noted that knowledge is situated; as we put it, it is a view from somewhere. The debate now shifted to an examination of that social space and the positions that we inhabit in the formulation of our ideas, as well as our practices. This forms part of the armoury of a reflexive social

science, where the tools of social inquiry are turned back on themselves in order to examine the conditions under which knowledge is produced in the first instance (Steier 1991, Bourdieu & Wacquant 1992).

From this starting point both Marxism and neo-Marxism consider the relationship that exists between facts, values and ideology. We now have to consider the role of power in the construction of truth. This we found to be based upon an ontological view that there existed a true state of consciousness that was masked by prevailing economic, social and political conditions. Value-freedom in such a context would be symptomatic of a desire to mask the truth. Hence, this view inverted the standard conception of objectivity as the disinterested pursuit of knowledge. This then translates itself, for example, into a programme of social research that generates a series of insights into the aims of social movements who oppose the prevailing social order. The value of such work is not then measured by positivist conceptions of truth, but by its ability to contribute to a more enlightened state that might free people from the constraints of ideological control.

The nature of this contention, particularly from those scholars associated with the Frankfurt School of Social Research, led to a debate with Popper who took a more instrumental view on the practice of science: that is, a problem-oriented perspective. This led to a distinction between scientific and extra-scientific values. However, for those such as Habermas this was a distinction, predicated upon rationalism, that ultimately broke down. Furthermore, it led to a positivist conception of knowledge as exemplified by the desire for a technical-instrumental control of the social and natural worlds. These opposing views often centred upon the difference between an epistemological and ontological position where the latter was exemplified, at least in the writings of critical theorists up to, but not including Habermas, in philosophical anthropology. It was at this point that we considered the arguments of feminist standpoint theorists.

Standpoint feminism has its starting point in the idea of women as the "other". We find the idea of the dominant culture being male, from which women are excluded. This discrimination is then turned into an advantage for it forms a privileged epistemic position from which to view social relations. Add to this a series of unexamined dichotomies on which our thinking has based itself and we have new grounds for knowledge from a feminist perspective. In the process, dominant conceptions of objectivity are defined as being symptomatic of male values.

Tensions within standpoint feminism were examined in terms of its

potential towards relativism. However, it is at this point that the separation of scientific and non-scientific values becomes of importance once again. It is the social, political and economic conditions under which science proceeds that, inevitably, affect its conduct. Therefore, as with such debates within Marxist circles, to imagine a feminist standpoint science in a feminist society lies beyond our current comprehension. We were left, once again, with an orientating principle that informs scientific practice, whose ends may be those towards which we strive in the hope that we will ultimately reach them. Feminist standpoint science may thus be characterized as possessing an ethos, informed by an ethic, ultimately orientated towards a set of political goals: that is, a change in the structure and relations of society.

Our conclusion to this chapter was a play on its content: social science is not, nor ought it to be, a value-free endeavour. To this we might also add the natural sciences. Instead, we should be vigilant about the ways in which values inform our activities in the conduct of research. This issue and some of those we had examined in previous chapters were then taken into consideration when examining the research process in Chapter 6. Here we could not exhaust our discussions, but merely serve to illustrate some of the ways in which a philosophical reading of the research process helps to sharpen our insights into its practice. In a sense, this is exactly what Chapter 7 continued to do only this time from a philosophical angle associated with postmodernism and poststructuralism.

The post-critiques aim, to differing degrees, at the very heart of the assumptions of scientific practice that have a long historical pedigree. It was for this reason that we took the critiques of epistemology and ontology as the focus of the first part of this chapter. Starting with Kant, we find the centring of the individual in terms of knowledge production. Reason was the guarantor of scientific objectivity and generalization. In contrast to this view, some post-critiques celebrated relativism and severed the link between knowledge and liberation. Indeed, any form of generalization in the name of reason was regarded as tyranny. This nihilist position was evident in the writings of a number of authors within these traditions.

When it comes to the translation of their work into a programme of social research, it is clear that a number of people have found inspiration in the post-critiques. However, we argued that it was not without significance that those ideas that have appeared to have the most impact on social research, particularly those originating from Foucault and Derrida, may be read from a Kantian vantage point. Baudrillard's "play" with ideas results in the collapse of the social and with that the idea of the

social sciences. It is here perhaps that we find nihilism at its height, despite Baudrillard's assertion that he is not a postmodernist. To this extent, we concluded that for those who have sought to employ the post-critiques in the service of social research, these have acted as "sounding-boards" against which to measure the grander claims of a modernist-based science. The question for some then becomes how to re-frame the status of critique following the postmodern onslaught (Simons & Billig 1994).

So we reach the end of our journey. This has been a complex one but also, we hope, illuminating. Interestingly, this parallels the way in which we would characterize the whole relationship between philosophy, social research and science. Indeed, scientific endeavours themselves are now more open to contestation, while systems in the physical world are seen to be more open; a long acknowledged characteristic of the social world. Ontologically, therefore, the principal difference between the subject matter of the physical and social sciences may now be the order of complexity. From a political point of view, in considering the issues surrounding science and the environment, what Popper termed "extra-scientific values" have entered the terrain of inquiry to such an extent that any simple demarcation between the means and ends of research has become increasingly untenable. In these instances, politics so informs the evaluation and conduct of research that allusions to scientific values become more of a means of gaining some degree of autonomy from such considerations, than serve as an accurate characterization of the process of scientific inquiry itself. For the postmodernists, of course, these allusions would be based on faulty premisses drawn from Enlightenment discourse.

Perhaps at this late stage we might just outline our position on these arguments. Of course the demarcation between scientific and extra-scientific values has always been a hard one to maintain and even, in some instances, undesirable. However, this hardly means the adoption of the nihilism of some postmodernist discourses as a corrective to what is often seen as complacent modernism. To this extent, hermeneutic investigations of science have revealed how interpretation is as much a part of the conduct of the physical as social sciences. Nevertheless, to accept this, together with the observation that science and politics are interrelated, is not then to abandon the quest for explanations. As James Robert Brown puts it in his discussion of these issues in terms of the works of Rorty:

> Knowing why particular political strategies worked (or failed) is of obvious vital interest. The same can be said for science. I'm happy

> to join Rorty in lumping science and politics together, but let's try to explain the successes (or failures) of both, rather than turn our backs on them (1994:3).

We would concur with this argument. There is now evidence of a renewed dialogue in the philosophy of science and social science that is reconsidering the relationship between and nature of these disciplines. New views in philosophy abound, the result being that not only does such philosophical discourse permit us to see our endeavours in a new light, but that account must be taken of the daily practices that make up scientific work. Perhaps, then, we will not find it necessary to view the relationship between philosophy and research in terms of a simple dichotomy: for example, philosophy as "abstract" and the daily business of research as "technical". Instead, we will learn that all of our decisions, however informed, have philosophical implications, whilst philosophy, if it is to have an impact upon practices, needs at least to recognize the contexts in which scientists and social scientists work.