Scientific Communities, Objectivity and the Transformation of Science

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Abstract:

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Keywords: social influences | community influences | science

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Introduction

To our normal waking consciousness the world appears composed of pre-existing objects and relationships. At a basic level, we see a tree and know that it is real. We have a colloquial understanding that the tree is not created by our consciousness but exists outside us as an independent entity. This understanding is reinforced, both by the predictability of events and by our ability to manipulate our environment. The sun rises day after day. We learn confidence in this experience, so much so that we *know* it continues after our death. When we need firewood we gather it from the forest or girdle and fell a tree. We experience ourselves as masters of our environment, as active agents in a pre-existing world.

This picture of ourselves as active knowers and doers is extended in the conventional view of science. Most scientists adopt similar attitudes in their scientific and non-scientific lives. They see their scientific activity as directed toward discovering facts about a pre-existing world. Experimental corroboration is used as supporting evidence for the existence of objective facts: facts that are not dependent on any particular observer, facts are about the world as it really is. Once discovered, we use scientific facts to manipulate the world according to our desires. We take the success of these manipulations another indication of the objective nature of scientific knowledge.

Difficulties with these views of knowledge arise when we learn that there is a social component to both our scientific and colloquial knowledge. Scientific knowledge depends on confirmation and critical review, both of which are social process. Our colloquial knowledge is also influenced by social interactions, by the language we speak, and the culture we inhabit. For instance, the Aranda people of Australia use the term *altjiranga mitjina* to refer to the time-outside-time that exists in dreams but which, to the Aranda, is also the time in which their ancestors live (Rheingold 1988). To the Aranda there is no difference between the time of their ancestors and the time during which they dream. This term and the culture that surrounds it imply a very different relationship to the world than we experience based on our scientifically trained consciousness.

In this paper I explore some characteristics and consequences of social influences on scientific knowledge. I begin with a consideration of community influences on the practice of science. In these considerations I have been influenced by the work of Barfield (1988), Bloor (1976) and Longino (1990). These ideas lead me to a consideration of the relationship between our perceptions of what we take to be the objective world and the "reality" that underlies these perceptions. I also explore the way communities and individuals become the vehicles for the manifestation of certain views of the world, views that are both culturally relative *and* true. Finally, I return to science to suggest methods by which we can extend current scientific conceptions and practices.

The Scientific Method

Open an introductory science textbook and you are likely to find an explanation of the scientific method (for example: Atkins, 1994; Haviland, 1994; Solomon et al., 1995; Mader, 1993; Hill, 1992; Giancoli, 1991). According to these accounts science is a rational, objective process that leads to well supported, but tentative, conclusions about the world.

In one such account, Mader (1993) describes the scientific method as beginning with observation of the natural world. Observation leads to the formation of hypotheses that guide further observations or lead to experimental tests. The results are new data, which may be used to modify the original hypothesis or may lead directly to a conclusion (Fig. 1, after Mader, 1993). As supporting evidence accumulates, a hypothesis may be transformed into a theory and eventually into a law. But no matter how well supported, or so the text book interpretation goes, scientists never treat their theories as facts. They are always ready to abandon a theory if conflicting evidence is found. I will refer to the types of models exemplified by Mader's (1993) treatment as *rational models* because they assume the operation of purely rational human beings.

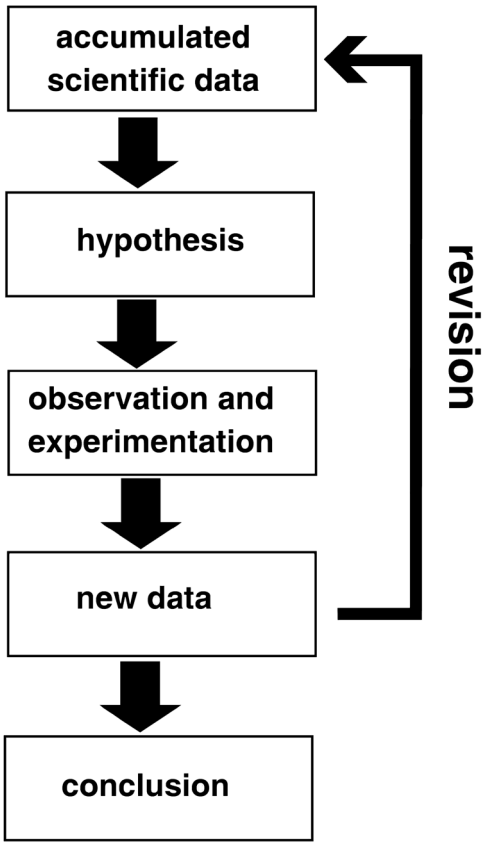

Fig. 1: Steps in the scientific method

An assumption of the rational models is that there is a set scientific method, or even a scientific mode of thought (Easley and Tatsuoka, 1968). They assume it is possible to proceed rationally through a sequence of steps to reach a conclusion. Of the books I surveyed, only Haviland (1994) discusses any limitation to this assumption. He points out that while useful, hypotheses can seldom be tested objectively. On the contrary, scientists tend to become attached to their hypotheses and are resistant to accepting contrary evidence. He supports this claim with an example concerning the interpretation of Mayan ceremonial sites.

The Classic period of Maya civilization occurred between 250 and 900 A.D. in what is now northern Guatemala, Belize, and parts of Mexico and Honduras. At present, much of this area is covered with dense jungle inhabited by people who sustain themselves through a system of slash-and-burn agriculture. This system of farming quickly exhausts the soil and new plots must be cleared every two or so years. Consequently, only small populations can be maintained in a system where slash-and-burn is the predominant agricultural system. When North American and European archaeologists began investigating the remains of the Maya sites, they asked themselves how the Maya could have maintained

large settlements based on slash-and-burn agriculture. Since clearly they could not, the great Mayan sites must have been ceremonial centers inhabited by few people, not major living sites. This question and its answer were influenced not just by the evidence but by the archaeologists' cultural bias against the rainforest as places to live. The interpretation of the Mayan sites as ceremonial centers held until the 1960's when a new generation of archaeologist asked a seemingly straightforward question: Did anyone live at this site on a permanent basis and, if so, how many people lived here? Over the next decade intensive work demonstrated that at least one site (Tikal) was a major settlement inhabited by tens of thousands of people. The old idea of purely ceremonial centers was inconsistent with this new evidence (Haviland, 1994). As this example shows, conducting a scientific inquiry is not as simple a matter as the rational models make it seem.

One effect of the rational models is to give science a special status within the spectrum of human knowledge. Science is given a special place because, unlike the arts and humanities, it is based on a method that yields objective knowledge, knowledge of the real world. According to the rational models the most important step in the scientific method is hypotheses testing. The construction and testing of hypothesis is the scientific procedure that assures objectivity. If a hypothesis is not in accord with reality, it will not survive these tests, or so the story goes. The importance of hypothesis testing is enhanced by its presentation as a feature unique to science. The fact that hypothesis testing fits within the larger context of providing supporting evidence for a theory, is largely ignored (Goldstein and Goldstein, 1980; Sattler 1986).

In order to show the special character of scientific thought, supporters of the rational models occasionally contrast them with the mythological thought of so-called primitive man (Easley and Tatsuoka, 1968). According to this view, primitive human beings were awed and mystified by aspects of his/her environment and so invented mythologies to explain phenomena that were beyond his/her limited understanding. Easley and Tatsuoka (1968) view these mythologies as superstitious explanations for the phenomena of the natural world, phenomena that we now understand through science.

Science and Community

The rational models of science do not give a role to the community of scientists in the production of scientific knowledge. Science is presented as a universally valid method that produces objective knowledge. Even Whitehead (1926) is impressed by the universality of science. He speaks of the scientific outlook as universal, as "transferable from country to country, and from race to race, wherever there is rational society (Whitehead, 1926)". Thus, Whitehead (1926) implies that science transcends culture and that the results of science are universal, not relative to the communities that create them.

The presuppositions of this view are clear in Whitehead's (1926) phrase "wherever there is rational society." This phrase points to what Whitehead (1926) sees as a precondition for the development of science. He sees this precondition as so essential that he dedicates a good

portion of his book to tracing the origin of this attitude in Western society (Whitehead, 1926). Although he does not support the rational models of science presented above, he does support the existence of a culture of science. The fertile ground for this culture is prepared by the existence of rational society, society in which the belief in an "*Order of Things*, and, in particular, of an *Order of Nature*" makes sense (Whitehead, 1926). In this ground the practices of science can take root. Without this foundation, science might never have developed.

Whitehead's (1926) contention that scientific culture is based on a belief in an order of nature deals with science in its most general aspect. More narrowly conceived, science is based in the practices and beliefs of a specific community[1] of scientists. In its narrowest extent, this community may be a group of scientists working together on a project of mutual interest. At its broadest, the community becomes Whitehead's (1926) culture. No matter its extent, it is the community that decides which questions are worth pursuing, which judges the value of discoveries and that provides the context for the work of the individual scientist (Keller, 1985; Longino, 1990). Without this community and the values it provides, an individual's work would have meaning only for himself.

The community that guides an individual's work differs depending on his/her field and his/her level of activity. For students, the community that guides their initial interest in science is contemporary western-globalized culture, which gives a central place to science. For trained scientists, the community usually consists of other similarly trained scientists. As the scope of an investigation becomes more specialized, the group that is capable of understanding the research decreases. A paper that proposed a modification to a method for determining evolutionary relationships presupposes a familiarity with, and interest in, previously developed methods. Without this previous work there would be neither the impetus to carry out the new research nor an audience for it. Audience and research exist in a mutually supportive relationship. The audience provides the context in which the investigator works. The audience provides the incentive to begin the work, helps define acceptable methods, provides feedback in the process and gives meaning to the discovery. In these senses, the audience shares many features with the community in which the research arises. The difference is that the audience is often defined to be a subset of the community as a whole.

When a new scientific idea is accepted it is always accepted by at least part of a community of scientists. No idea or theory is, or can be, accepted in the abstract. It is always accepted by a specific group of people based on specific evidence (or prejudices). If a theory were not accepted by a specific group of people it would have to be accepted by everyone, or

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[1] I use the word community in a very broad sense. I mean a group of individuals who feel themselves united in a common striving or in the search for a common goal. In this sense a community can be as small as two people or as large as a culture. All that is needed is (1) some type of interpersonal communication, and (2) the willingness of one or both of the parties to modify their ideas or practices based on that communication. As communication increases, the chances for social interactions to effect theories also increases, but I do not see the amount of social interaction as being of primary importance. Rather the willingness of a scientist to modify his/her ideas is primary. In this I differ from Daston (1992) who restricts the ability of scientific communication to substantially influence scientific theories (i.e., to lead to socially constructed objectivity) to the period beginning with the middle decades of the last century when communication between scientist greatly increased.

by no one. In either case we would no longer be dealing with science, but with belief. For a theory to be universally accepted it would have to be divorced from the evidence that was initially used to support it. This is because few people are willing or equipped to review the evidence supporting the theory. Most people who accept its truth will have to do so on the strength of other people's testimony. Even within a scientific discipline few people take the time to learn and understand the arguments and evidence that support new ideas. This point is brought out by Eddington's quip that in 1919 there were only two people who really understood Einstein's theory of relativity, Einstein and Eddington[2] (Collins and Pinch, 1993).

In cases where only one individual accepts a theory the rest of society usually views his/her conviction as a personal belief. S/he may have followed standard scientific practice in coming to his/her conclusions but, lacking acceptance by other members of the scientific community, his/her results are not supported by generally accepted facts. In convincing even one other person that his/her results are valid s/he begins to build a community that agrees with him/her on the significance of his/her work and on the validity of his/her methods.

The Individual and the Community

Scientists, like members of any community, can lose sight of their community membership. This is because the values and background assumptions that shape the community are often transparent to its members. Loss of perspective is especially likely in technical disciplines that require long study to master and constant work to maintain currency. In these cases, the scientist may devote so much time to his/her discipline that s/he cannot find time to participate in other communities or to acquaint himself/herself with their ideas. S/he will, thus, invest most of his/her energy and much of his/her sense of self in his/her scientific work. Under these circumstances it is natural for him/her to lose sight of the importance of his/her scientific community in determining his/her knowledge. To this type of scientist, his/her scientific community becomes a defining feature of his/her world. His/her sense of self becomes tightly tied to this community and s/he loses sight of the constraints that the community imposes. The community becomes invisible, and the constraints of the community come to be seen as part of the world-as-it-is.

Longino (1990) provides an excellent analysis of how scientific communities influence the practice of science. Her analysis focuses both on how values are incorporated into science and how criticism transforms individual into scientific (i.e., community) knowledge. According to Longino (1990), new scientific knowledge is always produced and evaluated in a specific context, by specific people. The context is expressed through the background assumptions that infuse the discipline in which the scientist works. These assumptions may establish acceptable

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[2] Sir Arthur Eddington (1882-1944), the father of dynamical stellar astronomy, led a famous expedition to measure the effect of gravitation on light rays. This was done by measuring the apparent displacement of stars around the solar disk during an eclipse. A detailed account of this expedition is given in Erman and Glymour (1980) and summarized in Collins and Pinch (1993).

methodologies, or they may express theoretical concerns to which research must adhere. The background assumptions may specify the types of protocols to be used, such as requiring clinical research to follow a double-blind protocol, or they may specify theoretical positions to which research must adhere. Examples of the latter are "consciousness is an emergent phenomenon" or "all human disease is genetic in origin (Berg quoted in Olson, 1989)". These assumptions provide the vehicle for the incorporation of values and ideology in science. They are part of the context of scientific discovery.

When scientific discoveries are initially made, they bear not only the stamp of their context but also of the scientist who made them. This stamp may be idiosyncratic. It may embody the scientist's subjective preferences for certain methods, theories, modes of presentation, or what s/he sees as the relevance of his/her data to social or spiritual concerns. As an individual's results are assimilated into the body of science they are subjected to the scrutiny and criticism of other members of his/her scientific community. This scrutiny allows the community to at least partially remove the subjective (i.e., individual) element from the discovery (Longino, 1990). Objective knowledge is not the result of an individual's relation to his/her material but the result of community practices that act to remove the subjective element from discoveries (Longino, 1990).[3]

Although criticism transforms individual results and incorporates them into the canon of science, it does not remove all values from science. Rather, it brings the investigator's assumptions and idiosyncrasies in line with those of the community. In other words, it incorporates the discovery into the context of the larger scientific community as expressed through the background assumptions of that community (Longino, 1990).

The transformation of a discovery and its incorporation into science need not transform just the discovery. New discoveries or theories always have the potential to transform the pre-existing assumptions of the community that spawned them. This transformation may be subtle or radical depending on how the discovery is received, how it fits with other work currently occurring in the field and how readily it is confirmed. The fate of a new idea also depends on the strength of the supporting evidence, the number of unresolved problems in the field, and not least on the standing of the scientist including his/her institutional affiliation.

Although Longino's (1990) analysis demonstrates the role of communities in producing scientific knowledge, she does not imply that communities are efficient at generating consensus among their members. Members may retain their idiosyncratic views even in the face of widespread disapproval by other community members. Where these idiosyncratic views are put forward by a respected scientist they may retain a prominent, though subordinate, position within the accepted canon. Pauling's (1976) ideas on vitamin C and Duesberg's (1988, 1991, 1992) idea that AIDS is not caused by HIV infection are examples of this phenomenon. When minority opinions are held by individuals of lesser stature, they are often ignored. Evidence usually plays a minor role in making these decisions. This is because evidence is always

[3] I am indebted to Kenneth Caneva for bringing this problem to my attention.

interpreted in the light of some theory, it is not theory neutral (Kuhn, 1962). In the debate over a new discovery, each side will select the portion of the evidence that they see as most relevant to their argument (Collins and Pinch, 1993). Data selection will be influenced by each side's background assumptions about their field. Since these background assumptions are seldom questioned within a community, they are similar to aesthetic criteria, criteria that are applied simply because they feel right (Keller, 1985; Kirchoff, in press). The ideal of the objective scientist impartially weighing the data is a myth. Scientists always interpret data from the context of some theory, which is embodied in a community of scientists (Kuhn, 1962; Longino, 1990).

Socialization of the Scientist

To understand why objectivity has been preserved as a defining feature of science, we have to consider how scientists are socialized into believing in objectivity. This takes place primarily through scientific instruction.

Through instruction students are socialized into believing in the existence of an objective world, a world that can be known with a very large degree of certainty. This belief is conveyed to the students even while telling them that good scientists always treat their knowledge as tentative; that scientific knowledge is not absolute; that what they will learn in their science classes may be modified in the future. The seemingly impossible task of getting students to believe that scientific knowledge is tentative, yet essentially correct, is accomplished by divorcing the facts of science from the process of discovery of these facts. I will illustrate these points with reference to my discipline of biology.

In a typical introductory biology class students are required to memorize and reproduce facts (often disguised as vocabulary) about living organisms. In less enlightened classrooms the students are required to reproduce these facts on multiple choice examinations. In more enlightened classes (or wealthier universities) the students are often asked to apply their scientific knowledge to situations they have not previously encountered. For instance, a student may be asked to apply the principles of diffusion to the movement and interaction of two chemicals in a slab of agar. Although the latter approaches are a tremendous advance over the former, they are based on and teach the same lesson about the world: non-contextual, objective knowledge of the world is possible and desirable.

When students are required to memorize facts, either to apply them to problems or to reproduce them on a test, they are socialized into believing that these facts represent true knowledge. The students come to believe that there is an external, objective world and that objective knowledge of this world is possible. The word objective comes to be equated, in some imprecise way, with good. Why else would they be required to spend so much time memorizing facts? The lip service that is paid to the scientific method, usually at the beginning of the course, is largely ignored by the students. In most cases there is little class time devoted to study of the scientific method. When it is discussed, its lessons are not reinforced during the

rest of the semester. Much more time is spent on the meat of biology: the factual knowledge that the students will need in their advanced courses. In these ways, the students are socialized into a belief in objectivity and objective facts without the need to articulate these assumptions. These consequences are intensified by the student's predilection for viewing received knowledge as truth (Erickson and Strommer, 1991).[4]

As a student progresses in his/her studies, s/he begins to read the primary scientific literature. The tone and writing style of this literature strengthens the messages s/he has received from his/her classes. Most scientific papers are still written in the passive voice though there is a growing trend to teach students to use the active voice in scientific writing (McMillan, 1988; Moore, 1992). One problem with the passive voice is that it downplays the role of the scientist in conducting the research s/he is presenting. The results are presented as if they were universally true. As if their discovery by this particular author using these particular methods were purely accidental. The implication is that the same results and conclusions could have been reached by anyone else. The student sees this writing style as a confirmation of his/her belief in the reality of an objective world. If this belief is comforting to him, s/he will be more likely to pursue research in science, perhaps by participating in an undergraduate research project in a faculty member's laboratory.

In making the transition to research, a student may confront a monumental change in the way(s) s/he views science. S/he begins to participate in the process of creating knowledge instead of merely receiving it. This can lead him/her to question the assumptions that underlie his/her education. In my experience this rarely happens. The transition to research takes place under the supervision of a faculty mentor and, in larger laboratories, several graduate students and post-docs. These supervisors lead the student into the creation of knowledge so that s/he does not question the philosophical underpinning of his/her activities. S/he is encouraged by the behavior of the people around him/her to retain his/her belief in the objectivity of the scientific method and of the facts that s/he participates in discovering. If s/he is trained well, s/he becomes aware of artifacts that could result from the techniques s/he learns, but s/he is not usually encouraged to explore the assumptions or limitations of the community in which s/he works. If s/he has religious interests that might cause him/her to question the ontological or epistemological assumptions of science, s/he is encouraged to keep these separate from his/her day-to-day activities in the laboratory. S/he may be able to discuss these interests with other members of the lab or s/he may be allowed to pursue an independent project on his/her own ideas, but some member of the lab will always make it clear that these interests are peripheral to those of the lab and to science in general. In these ways a student learns how communities of scientists work. S/he is exposed to the types of questions they ask and what they exclude from their investigations. If s/he holds beliefs contrary to those expressed in the

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[4] As a student progresses through their college years they change their perception of the learning process. Perry (1970) and Belenky et. al (1986) found that freshman often view their teachers as authorities who know the truth which they impart to their students. Students at this stage of intellectual development view knowledge as truth.

lab, s/he may leave the lab or science altogether. More commonly, if s/he has reached this stage s/he accepts the lab procedures and constraints as part of the process that yields objective knowledge. S/e is a step closer to becoming a full member of the scientific community. If s/he pursues this path to the fullest s/he may come to equate scientific objectivity with validity and to deny validity to other ways of knowing.

Social Construction of Objectivity

In contrast to the belief that scientists *discover* objective facts about the world, Longino (1990) emphasizes the role of communities in *creating* knowledge. In doing so she treats objectivity differently than is common in the sciences. Instead of attributing objectivity to the scientific method or to the creative powers of the individual, Longino (1990) sees objectivity as the result of a community process. What is objective (i.e., what is taken to be true of the world) results from a process of evaluation and criticism within the community. By stripping the personal element from discoveries, the community creates an impersonal view of the world that is equated with objective knowledge. What is objective is what a community calls objective.

Barfield (1988) comes to a similar, though more general, conclusion through a study of language and perception. For him, not only scientific knowledge but all knowledge (including perception) is the outcome of a community process. Barfield's (1988) ideas underlie much of this paper.

For Barfield (1988), a representation is something that a person perceives to be there. Trees, tables and other enduring objects are all representations. So are rainbows, mirages and hallucinations. The difference between the objects of our environment and hallucinations is that the former are collective representations while the latter are individual. Collective representations are representations we share with others. They are the representations that we agree on. It is this agreement that transforms our individual representations into collective representations and allows us to deal with these representations as objective components of the world.

In common usage, the word objectivity has at least two meanings besides that assigned by Barfield (1988) and Longino (1990). First, it refers to a world of things that exist apart from human knowledge of them. Scientists assume that the characteristics of these things can be, and at least sometimes are, known (Whitehead, 1926). This knowledge is treated as objective if it accurately reflects the nature of the objects under study. Second, objectivity is used to refer to the care an individual takes in designing and implementing experiments and in making observations. In this sense, objectivity refers to the removal of the personal element from science by the scientist himself. A scientist is said to be objective if his/her work leads to objective knowledge.

Daston (1992) clarifies these meanings of objectivity and distinguishes them from Longino's (1990) use of the term (he does not cite Barfield (1988)). He distinguishes between

three types of objectivity: aperspectival, ontological, and mechanical (Daston, 1992). Aperspectival objectivity is the type of objectivity championed by Longino (1990). It is concerned with the social elimination of individual perspectives in the construction of the scientific canon. This type of objectivity is closely related to Sattler's (1986) conception of inter-subjective objectivity. Ontological objectivity deals with the correspondence between theory and the (independently existing) world. Mechanical objectivity is concerned with the relationship of the individual to his/her subject matter. It is about suppressing, at the level of the individual, the tendency to incorporate subjective judgements into science.

In the remainder of this section I argue that, at least for contemporary science, there is much less difference between aperspectival and ontological objectivity than is implied by Daston (1992) and than is assumed by scientists. In the last resort, knowledge of what is in the world (ontology) is social knowledge (i.e., is due to aperspectival objectivity) (Barfield 1988). The individual has important roles both in creating and in receiving this knowledge, but it is the scientific community that evaluates and validates his/her work and gives it a context. Without this context, an individual's knowledge would remain solely his/her own property and would die with him. A scientist who reports his/her observations on fire-breathing dragons will be scorned unless others can repeat his/her observations or are convinced by the strength of his/her evidence. If his/her observations pass community scrutiny, they become part of what that community accepts as the objective world. To take a more abstract example, Whitehead's (1926) lectures on Science and the Modern World have meaning precisely because they were lectures. That is, because they are addressed to a community that shares a common framework with him.[5] Without this community to give meaning to his ideas, Whitehead would be unknown.

Through the community processes that lead to aperspectival objectivity a community builds up a common picture of the world-as-it-is. By the world-as-it-is I mean the socially constructed view of what exists in the world. This socially construction permits general agreement on the characteristics of the world. As Longino (1990) points out, scientific communities create their characteristic views by forcing adherence to standards of evidence and by insisting on corroboration of unusual observations. That is, by applying the community standards of aperspectival objectivity. What is created through this process is viewed by the community as real, as ontologically valid. Ontological objectivity is thus assured by the practices of aperspectival objectivity. What is real is what the community takes to be real.

The basis for assessing a theory's ontological validity lies in the *interactions* between the world and the community that holds the theory. Many of these interactions are conditioned by the community procedures that act to remove individual proclivities. The way in which a

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[5] I do not mean to imply that Whitehead's (1926) framework is identical to that of his audience. All that is necessary is that the audience share knowledge of the Western philosophical and cultural heritage with Whitehead (1926) and that they view his remarks in this context. Without this common framework his remarks, for instance on the difference between the subjectivist and objectivist positions, would be largely unintelligible.

community collects and processes evidence and the background assumptions of that community, influence which aspects of the world the community takes to be objectively real. In other words, the community practices that lead to aperspectival objectivity also influence how the community evaluates claims of ontological objectivity. When a new hypothesis is proposed, it is subjected to criticism. This process removes the elements that the community perceives to be due solely to the subjective experiences and predilections of the originator. The elements that remain are, for that community, part of the world-as-it-is.

Discoveries, theories and more generally knowledge about the world, are relative to the community that creates them. Knowledge is relative both to the methods used to reveal it and to the community in which this knowledge is held. For instance, statistical correlation only exists because there is a statistical methodology that is embodied in a community of scientists who believe that statistical methods present valid ways of studying the world. In as much as the communities who apply them believe that these methods reveal the underlying structure of the world, the communities construct a world-as-it-is, a consensus reality that is projected onto the underlying being of the world.

In attributing ontological objectivity to the procedures of aperspectival objectivity I have identified only one aspect of the interaction between these two types of objectivity. Not only do community procedures lead to ontological objectivity but what is accepted as ontologically valid (i.e., the world-as-it-is) influences the procedures the community establishes to assure aperspectival objectivity. For instance, the selection of which elements of a hypotheses are viewed as subjective is influenced by the community's perception of the nature of the world-as-it-is. Thus, the fit between theory and the world (ontological objectivity) is evaluated based on community practices (aperspectival objectivity) that presuppose the nature of the world-as-it-is.

Daston's (1992) third type of objectivity, mechanical objectivity, differs from his/her other two by its focus on the individual instead of the community. Mechanical objectivity can be seen as the process by which an individual trains himself/herself so that s/he is better able to perceive the "true nature of the world." The difficulty with this is seen when we realize that what we call the "true nature of the world" is dependent on the communities to which we belong. In the above analysis I have argued that the "true nature of the world" is created by a community following the procedures of aperspectival objectivity that are accepted by that community. Thus, an individual's training to suppress his/her own predilections can lead him/her to introduce community standards into his/her work. In fact, the better s/he is at incorporating community standards, the more readily will his/her work be accepted. To the extent does this, s/he does not lead himself/herself further toward some hypothetical "true" nature of the world, but further into participation with a community.

Human Knowledge and The World

So far, I have argued that the procedures that a community uses to strip new discoveries

of their idiosyncratic element also function to validate claims about the world. This procedure leads to the creation of the world-as-it-is. I have also argued that in attempting to purge himself/herself of his/her strictly individual views, a scientist may unconsciously adopt the viewpoints of a community. Thus, s/he leads himself/herself further into a socially constructed view of the world rather than away from it.

Despite this beginning I do not subscribe to the social constructionist view that contends that scientific knowledge is *only* social knowledge. That is, that scientific knowledge can be reduced to *arbitrary* social conventions. Bloor (1976)[6] himself seems to reject this view.

> Naturally there will be other types of causes, apart from social ones, which will co-operate in bringing about belief. (Bloor, 1976 p. 5)

> To see scientific theories and results as conventions is said to imply that they become true simply by decision and that any decision could be made. The reply is that conventions are not arbitrary. Not anything can be made a convention, and arbitrary decisions play little role in social life. The constraints on what may become a convention, or a norm, or an institution, are social credibility and practical utility. Theories must work to the degree of accuracy and within the scope conventionally expected of them. These conventions are neither self-evident, universal nor static. (Bloor, 1976 p. 37)

In rejecting a pure constructionist view of scientific knowledge, I do not advocate for the existence of unconditionally true knowledge of the world as an alternative. I believe that dichotomy between social construction and truth is a false dichotomy. Knowledge can be both socially constructed and true. To see how this is possible, I will explore the nature of human knowledge and the relationship of "true" knowledge to the world.

Human knowledge is knowledge that exists in human consciousness. While this may seem to be an obvious statement, it has broad consequences that are not immediately obvious. Because our knowledge is human knowledge none of it can legitimately be considered privileged: existing prior to its manifestation in our consciousness. If it existed, privileged knowledge would be knowledge of the ultimate reality of the world. It would give us insight into unmediated reality before it appeared in our consciousness. To make this clear I draw your attention to the fundamentalist religious view that the Bible is the result of divine revelation and expresses God (not human) knowledge. Although some fundamentalist communities accept this view as true, many outside these communities recognize that this as a claim made by human beings, a claim embodied in a human community. Thus, what is privileged (true) knowledge to members of the community is an example of a human claim to knowledge to

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[6] Bloor (1976) is the founder of the strong program in the sociology of knowledge. This program asserts that all knowledge has a social component, that social factors influence what people take to be true. Bloor's (1976) analysis is primarily concerned with scientific and mathematical knowledge.

those outside the community. My assertion is that all knowledge is human knowledge and, as such, is embodied in human communities.

The parts of knowledge that I will focus on here are our representations of the world (Barfield, 1988). All of the objects that we normally perceive as existing apart from our consciousness are representation, not independently existing objects. They are our images of the world, mediated to our consciousness by our senses. We take these images to be objects that exist apart from our consciousness because we project them into the world.

Many scientists and philosophers have recognized that we know the world only indirectly (Joad, 1936). Sir Arthur Eddington (1930) explained the process in the following manner.

> Consider how our supposed acquaintance with a lump of matter is attained. Some influence emanating from it plays on the extremity of a nerve, starting a series of physical and chemical changes which are propagated along the nerve to a brain cell; there a mystery happens, and an image or sensation arises in the mind which cannot purport to resemble the stimulus which excites it. Everything known about the material world must in one way or another have been inferred from these stimuli transmitted along the nerves . . . the mind as a central receiving station reads the dots and dashes of the incoming nerve signals . . . But a broadcasting station is not like its call-signal; there is no commensurability in their natures. So too, the chairs and tables around us which broadcast to us incessantly those signals which affect our sight and touch cannot in their nature be like unto the signals or to the sensations which the signals awake at the end of their journey . . . It is an astonishing feat of deciphering that we should have been able to infer an orderly scheme of natural knowledge from such indirect communication. (Eddington, 1930)

While Eddington (1930) recognizes that our images of the world are shaped by our senses, he still accepts the existence of a world of objects apart from our experience of them. To see the fallacy of this view, we need only ask ourselves how Eddington knows that there a world of chairs and tables that broadcasts to us. Either he has access to privileged knowledge that allows him to know the world apart from the way it appears to his/her senses, or he has created that world by projecting his/her representations onto the preexisting substratum of existence. I reject the first alternative for the reasons given above.

From these considerations we can see that what we call the world can better be regarded as a representation in our consciousness. The tree outside my window does not exist independently of my consciousness but is a representation in my consciousness. The claim that there is a real tree out there is a human claim to privileged knowledge. This claim states that by some undisclosed process the person making the claim has access to the true nature of reality, which includes knowledge of the real existence of the tree. This claim to knowledge is similar to

the claim made by fundamentalists about the Bible. If it still seems otherwise, I ask you to consider the possibility that this is because you are a member of culture (Western) that has emphasized and reinforced the idea of an independently existing world. As in scientific training, reinforcement takes place primarily through social means - discussions with friends and colleagues, readings, education that emphasizes memorization of facts (about an assumed independently existing reality), etc. These social factors contribute to our belief in an independently existing world. In as much as our representations are shared by communities of people, they are collective representations (Barfield, 1988).

Beyond Subjectivism

Although I cannot support the existence of a preexisting, objective world of objects, I do not believe that the representations we form are purely subjective or arbitrary. I want to draw your attention to several experiences that suggest that although there is an individual and social context to our representations, this is not the whole story. Whitehead (1926) points to two of these experiences in arguing against subjectivism. First, it appears to our everyday consciousness "that we are *within* a world of colors, sounds, and other sense-objects, related in space and time to enduring objects such as stones, trees, and human bodies (Whitehead, 1926)". Second, our ability to act effectively in the world suggests that there is a world beyond our subjective experience. Our actions are directed at accomplishing some aim in the world. That we are successful in at least some of these aims points to the existence of a world beyond our subjective experience (Whitehead, 1926).

In addition to our individual experiences, our social interactions also suggest that the world is not merely our subjective creation. Both our experience of a world of objects and our ability to act on this world are created and reinforced through social interactions. These interactions strengthen our conviction that what we see and act on is not merely our subjective creation. Other people agree with us on the existence of certain objects and on the effects of our actions on these objects. There must be some basis for this agreement, or no agreement would be possible. There must be "something" in the world that allows community members to agree.

If we look at the process of social construction not as member of one of the communities, but as a sociologist of knowledge, we come to a perspective that supports the notion that there is "something" beyond the socially constructed world.[7] Communities construct a shared view of the world-as-it-is according to certain principles or procedures that are taken to give insight into the true nature of the world. The view thus constructed is continually tested and reinforced through community procedures (see Evans-Pritchard, 1937 for a cultural example). Although most tests lead to reinforcement, it is possible for shifts in

[7] Sociologists of knowledge are, of course, another community. The perspective they bring is influenced by social factors just as much as is any other perspective (Bloor, 1976). I do not mean to imply that sociologists of knowledge possess privileged knowledge.

perspective to occur through new ideas, experiences, or cultural contacts than bring novel elements into the community. Their world views are dynamic not static. Part of this dynamic process results from the continual confirmation of what the community takes to be true. Testing is not the sole possession of the scientific method (Evens-Pritchard, 1937).

Evidence for "something" in the world besides what is socially constructed comes from the fact that tests of a world view often reinforce rather than abrogate this view. Because communities can construct a *shared* view of the world there must be something in the world that forms the basis for this construction. The facts and theories that are revealed to specific communities by specific methodologies must be part of the world. Facts can be observed repeatedly, and theories can be confirmed within the context of the procedures used by the community. Most importantly, effective technologies[8] can be developed based on the view offered by a specific community.

In addition to our normal social interactions, we occasionally interact with people from different cultures. In these interactions, we can be struck by the high degree of cross-cultural agreement on the existence of at least some objects. Even in cases where there is a language barrier it is possible for people from radically different cultures to agree on the existence of certain things, trees for instance. The meaning and significance of the object may vary tremendously between cultures,[9] but individuals from different cultures should at least be able to communicate their experience of the existence of an object by walking up to it, slapping their hands on it and gesticulating at each other. These types of experiences suggest that there is "something" in the world that is not solely our individual or social construction.

The Unrepresented

These considerations lead to the question: What is this "something" that appears to us through the various facts and theories of our scientific (and non-scientific) communities? The ability to repeat observations (within a given context) testifies to the existence of this "something." Additional evidence comes from the fact that various communities construct different, but effective, technologies based on their (sometimes mutually contradictory[10]) views of the world-as-it-is. The existence of these different, and effective, views of the world argues for the existence of "something" that is at least partially independent of human observation. I will follow Barfield (1988) in calling this "something" the unrepresented.[11]

What is the unrepresented that lies behind our representations? It cannot be anything

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8 I use this word in a very broad sense to mean practical application of knowledge to solve problems that are posed by some community.

9 For instance, a peyote cactus has very different significance for a member of the Native American Church and a plant taxonomist (see Fire and Erodes (1972)).

10 For instance, compare the view of the human organism implicit in Traditional Chinese Medicine (Kaptchuk, 1983) and modern Western medicine (Jacob et al., 1982).

11 Sattler (1986) calls it the "Unnameable."

that we represent to ourselves as existing in the world. These are merely the individual and collective representations that we project onto the world. Thus, the unrepresented cannot be an objective, pre-existing world outside our consciousness. The unrepresented must lie behind our creation of the objective world-as-it-is. The unrepresented is the basis for this creation.

The unrepresented is **radically prior** to our representations. It exists prior to and outside of our representations. It is beyond any image we can form of it. When we try to picture it, we enter the world of representations of which the unrepresented has no part. We can think of one aspect of the unrepresented as the potential that becomes actualized as it enters our consciousness in the process of forming representations. It is not the representations themselves, but the existence of collective representations that point to its existence. It is the only part of the world that exists outside human consciousness. In this sense, it is the only part of the world that is real.

I hope it is now possible to see why I consider our collective representations and conceptions of the world-as-it-is to be both socially constructed and true. The world-as-it-is is true just because it is socially constructed. It was the recognition of its social construction that lead us to recognize the existence of the unrepresented. This knowledge (of the existence of the unrepresented) allows us to see the world-as-it-is as an image of the unrepresented. Our constructions are true in that they are "of the unrepresented." They are partial in that they are constructions. The mistake we make in our ordinary life is to take our representations as embodying all of reality. They are partial embodiments of reality (the unrepresented).

In its most general sense, the unrepresented is that which reveals itself to us through our experience of it. This revelation can take many forms: naive sense experience, philosophical investigation, scientific experiments, intuitive perception, mystical experience etc. These different modes of experience are embodied in the many communities of the world. The unrepresented reveals itself to us in all, or through all, of these modes. It makes itself known in the human processes of knowing it. The very act of knowing testifies to its existence (Steiner, 1886/1968).

Our experience of the unrepresented may be direct, through our senses, or may be mediated by instruments that extend our senses. In both cases our experience of the unrepresented is filtered. Sense experience is influenced by the constitution of our senses and conceptions we hold about the world (Husserl, 1964; Joad, 1936). Instrumentation is constructed to exaggerate certain of our sense experiences in a way that is both repeatable and corresponds with other lines of evidence. In these processes, filters are imposed on our interaction with the unrepresented, but we are still dealing with the unrepresented. No matter how we manipulate our senses or instruments, they still allow a manifestation of the unrepresented. The manifestation is shaped by our activity, but it is not transformed into something that is not an expression of the unrepresented.

Implicit in the above is the idea that the unrepresented is not completely revealed in any of our experiences or representations of it. To make this idea explicit, let us consider the

relation of a community to the unrepresented.[12] Each community brings its own preconceptions and predilections to its interactions with the unrepresented. The aspects of the unrepresented that the community experiences are thus filtered through these preconceptions. A community with different preconceptions will have a different relationship to the unrepresented. That is, the community will provide a different opportunity for the unrepresented to express itself. To maintain that the unrepresented is ever completely expressed in or to a community is to maintain that there is no possibility for the community to change. If the unrepresented were ever completely revealed it would be impossible for anyone to discover a new feature about the world or to view the world in a new way. Since we have already seen that our view of the unrepresented is conditioned by the communities we belong to, to say that the unrepresented is completely revealed would be to say that there would be no possibility of community development that would allow a further revelation of the unrepresented. Since even small changes in a community can cause profound changes in their view(s) of the world (Kuhn, 1962), it is unlikely that a community will ever exist that will provide all of the points of view necessary for the unrepresented to completely reveal itself.

Up to this point, I have discussed two very general characteristics of the unrepresented. (1) The unrepresented is that part of the world that makes it possible for individuals to agree and to form communities; (2) The unrepresented is never completely revealed. A corollary to these conclusions is that what we know about the unrepresented is always known in some context (community, historical, cultural). In other words, all knowledge is contextual.

The Community and its Relation to the Unrepresented

The community as the context for knowledge is the vehicle for the manifestation of some aspect of the unrepresented. The aspect that is represented depends on the interests, procedures and history of the community. Scientific communities are usually interested in the physical manifestation(s) of some aspect of the unrepresented or in developing technology to modify our interaction with the unrepresented. Physicists are interested in the structure of the non-living world, biologists in various aspects of organisms, etc. Within these disciplines various groups may form around interest in a particular approach to their subject. These smaller communities are sometimes called schools. Within a school there usually exists a certain uniformity of outlook and practice. Although members of the school may never meet, they are united by philosophical and methodological ties. These ties are maintained and strengthened through reading and reviewing each others' papers, exchange of students, collaborations, attendance at meetings, etc. Through these interactions the community strengthens its ability to allow the manifestation of some aspect of the unrepresented.[13] The work done by one person may stimulate another to develop his/her own work further, that is, to explore aspects

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12 A similar analysis could be done of an individual's relation to the unrepresented.

13 It also weakens its ability to allow the manifestation of other aspects of the unrepresented.

of the unrepresented that were previously unmanifest. As long as the individual remains in agreement with the precepts of the community, s/he elaborates that aspect of the unrepresented that is manifest through the community.

The community and the unrepresented exist in a mutually supportive relationship under which the practices of the community are matched by the manifestations of some aspect of the unrepresented. As new techniques or theories are developed they are tested within the context of the community's understanding and experience of the unrepresented. If they prove fruitful within this context, they are retained. If they do not, they are discarded.[14] Thus, a dialogue ensues between the community and the unrepresented. As the community develops, it enlarges the opportunities for the expression of an aspect of the unrepresented through development of the theories, practices and results that the community considers relevant to its concerns.

The Individual and His/Her Relation to the Unrepresented

The communities that form the context for knowledge of the unrepresented are composed of individuals whose experience of the unrepresented is mediated by the community. The individual embodies the ideas that are expressed in the community **and** influences the expression of those ideas by his/her activity. S/he develops the practices that allow him/her to be a vehicle for the manifestation of this aspect of the unrepresented. The better s/he becomes at this process, the more will his/her work be accepted into the canon of the community.

As discussed previously, training is one of the primary methods for the community to maintain internal consistency. New members of the community usually must complete a period of study to be regarded as full members. In communities that are considered privileged within their cultures these studies usually involve formal study or apprenticeship. During these years the student learns the facts of the discipline, the accepted methods for conducting research, and often unspoken epistemological assumptions that underlie the discipline (see above). If s/he is successful in his/her studies and later work s/he will most likely adopt this knowledge, methodology and assumptions as his/her own. S/he is thus socialized into the community.

The socialization of the individual into a community does not mean that s/he becomes a passive part of the community. If the community encourages active participation, as do most scientific communities, the individual will most likely see it as his/her duty to take an active part in adding to community knowledge and practices. In this way the individual always has the possibility of transforming the community through his/her activities. As an active member of the community s/he need not accept any of the community precepts as given. S/he can work to

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[14] The criterion for retention varies tremendously among communities. In scientific communities the criteria are usually related to experimental tests and theoretical consistency with other community held theories (or assumptions) (Popper, 1972). Of course, the abandonment of a theory or result is usually not community wide. Those least likely to abandon it are its discoverers.

change any of them. In this process the individual becomes the initial avenue for new manifestations of the unrepresented to reveal themselves.

Ritual in Science

If we accept the relationship between the community and the unrepresented that is outlined above, we see that participation in a community of scientists has ritualistic aspects.[15] In proceeding according to accepted methods of his/her discipline, a scientist follows procedures that have been shown to produce desirable results. In extracting DNA from living tissue a geneticist is careful to perform the extraction according to procedures that have been successful in the past. S/he may modify these procedures if they do not give him/her the full results that s/he wants, but s/he is unlikely to discard them altogether and begin anew. In following established procedures s/he is providing the conditions under which part of the unrepresented has been shown to manifest itself. His/her procedural modifications allow him/her to adapt preexisting procedures to his/her specific situation, to the specific manifestation that s/he hopes to elicit.[16] His/her actions are ritualistic in as much as they are performed repeatedly in order to bring about similar manifestations of the unrepresented. The procedures for DNA extraction are repeated precisely because they yield DNA. If they did not, they would not be repeated.

Scientists are generally unaware that the repetitive nature of their acts allows a manifestation of the unrepresented. On the contrary, they commonly view their actions as unimportant in bringing forth the phenomena they study.[17] Scientists usually regard the world as existing prior to and outside of their investigation of it. They see their work as uncovering the preexisting nature of the world. Since the world is preexisting, their actions in revealing it are not essential to its nature. They see organisms as existing and having their own characteristics that are separate from our perception or knowledge of them. They agree that at any time scientific knowledge will be incomplete and tentative, but scientists generally view scientific knowledge as objective in as much as it deals with the real, preexisting world. Because they imbue scientific knowledge with this characteristic, they see their knowledge of the world as unessential or even irrelevant to the true nature of the world. They believe that nothing of the true, external nature of the world would be changed if they changed their knowledge. While scientists are willing to treat most of their knowledge as tentative they treat the preexisting nature of the world as certain. It is the one piece of knowledge that is they accept as **known**. The mechanism of this knowledge, along with its validity, is rarely discussed.

An alternative interpretation to seeing the world as preexisting is to see the external

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15 I use the term ritual in a broad sense to mean the performance of a set of acts or practices that are carried out in order to bring about some desired result. In this, I follow the usage of Leach (1968).

16 For instance, s/he may wish to extract DNA from a newly discovered species of plant. The particular chemical composition of this species may require modified procedures.

17 The awareness of quantum entanglement in high energy physics may be an exception to this statement.

world as a projection of our representations onto the unrepresented. The projector creates the seemingly external world then forgets that s/he has participated in this creation. S/he views the image as the real world, as constituting all of reality. Recognizing this process avoids assigning privileged status to part of our knowledge. It allows us to see knowledge as arising in the interaction between ourselves and the unrepresented. In as much as these interactions are based on the repetition of prescribed actions that are designed to bring about a given manifestation/result, we are dealing with ritual.[18] According to this view, there is no real preexisting world apart from our knowledge of this world. As we change our knowledge, as we adopt new rituals, we change the world. These changes may be minor or radical.

A Step to Transforming Science

Are current scientific methods the only way to conduct science? Can science be done in a way that brings new portions of the unrepresented to manifestation? Is it possible to experience the unrepresented in another manner than we are accustomed to today? I believe that it is possible to find new and effective approaches to science. In the remaining sections of this paper I will briefly explore three methods that have the promise of changing the way we do science. In this discussion I will refer primarily to biology, the field I know best.

Like other scientific theories, most biological theories presuppose the existence of a real, objective world. The theory of evolution is a theory about the evolution of real organisms; organisms that exist prior to and outside our consciousness of them. But I have argued that the existence of this objective world is a projection of our representations onto the unrepresented. The organisms of our familiar environment are our representations, not objects with the fixed characteristics that we take them to be. That there is "something" in what we call an organism besides our representations is clear from the fact that we can agree on what we call an armadillo, for instance. However, we make a mistake if we think that our current representations embody **all** aspects of the unrepresented that underlie organisms. As I have argued, the unrepresented is never completely manifest in our representations, or in our theories. There is always the possibility of changing our theories by changing the aspects of the unrepresented that we bring to manifestation: by changing what we include in our representations. In this sense, all biological theories are incomplete. They embody an incomplete view of the unrepresented that comes to expression in and through organisms.

A step toward changing how we do biology would be to change at least one aspect of our representations. Since what we represent to ourselves as an organism is influenced by our conceptual expectations, changing our conceptions is a step toward changing our representations (Farthing 1992 p. 31). As we create our representations, we endow them with

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[18] In religious communities the repetitive actions (rites) often appear to be prescribed by religious authority. However, the existence of synods and ecumenical councils shows that the creation of rites is also a social process. In scientific communities the social prescription of methodology is more overt. The techniques used by one lab are taken up and modified by another in an ongoing social process.

certain features and deny them others. We can consciously expand our representations by expanding our conceptions to include aspects that currently only exist in potential (in the unrepresented). For instance, there has been a long debate in biology on the existence of an inner life of emotion and thought in organisms. For the most part, biologists have excluded these psychic aspects from their conceptions of non-human organisms. Consequently, biological theories have turned to materialistic, behavioristic or, more recently, sociobiological explanations to account for animal behavior and evolution. These scientific theories have been constructed to emphasize certain aspects and to deny reality to others. Many scientific theories would change significantly if we enlarged our conceptions of animals to include an inner life. Important steps in this direction have been taken by Griffin (1984).

An Intermediate Step

As an intermediate step in the transformation of science we can explore the scientific use of capacities that we have as part of our waking consciousness but which we are trained to ignore. Developing these capabilities will allow us direct experience of aspects of the unrepresented that currently exist only in potential. By bringing new aspects of the unrepresented into direct experience we bring about a more fundamental transformation of science than is possible by changing our conceptions. The change will be more fundamental because it will be grounded in our direct experience, not only in our concepts.

To me, our feelings and sense of aesthetics are two valuable faculties that have been underutilized in science.[19] Like our ability to form representations, these faculties have been trained through social interactions. If we are to use them in science, they will require retraining. It can be the task of scientific communities to train these faculties so that they can take their place alongside our highly developed analytical abilities (Kirchoff, in press).

As we learn to exercise these faculties, we will provide the conditions necessary to enlarge our representations. To the extent that we internalize and automatize them we will take a first step in changing our consciousness. This will allow a more fundamental transformation than allowed by the conceptual change discussed above. We will not merely agree to think about organisms differently but will learn to experience them differently. In this sense we would follow Goethe's suggestion of training our faculties to allow the world (the unrepresented) to reveal new aspects of itself (Zajonc, 1983). However, we should not expect these faculties to lead us to absolutely true knowledge of the world. Like any other human faculties, they will lead us deeper into the values embodied in our communities.[20] But they will

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19 By feelings I mean our intuitive sense for the wholeness of an experience. This sense is expressed through a feeling of rightness. The existence of this type of feeling is implied by Keller (1983) in her discussion of the work of Nobel Prize winning geneticist Barbara McClintock. A further discussion of the aesthetic criteria of modern science is in Keller (1985 pp. 115-126).

20 See Hofstadter (1965) for a discussion of how feeling was interpreted as a universal attribute of art, in specific artistic communities.

also provide the basis for the transformation of these communities and the revelation of new aspects of the world.

A Radical Transformation of Science

All our representations and theories depend on our normal waking state of consciousness. As we drift off to sleep (our most commonly experienced altered state of consciousness) we lose our ability to comprehend ideas and sensations that we can easily understand when awake. Instead, we find ourselves in a world of vivid dream images or of dreamless sleep. In both cases our familiar world of objects disappears. From these and other similar experiences we learn that our representations and theories are relative to our state of consciousness. As our state of consciousness changes so does what we take as existing in the world. If our most wide-awake state of consciousness were dreaming sleep (REM sleep; Buck, 1988) our world of representations would not include enduring, spatial objects. On the contrary, we would be able to volitionally alter the objects around us. Our experience of enduring objects is dependent on our waking state of consciousness. As we change our consciousness we allow different aspects of the unrepresented to come to expression.

A radical transformation of science can be brought about through a change in human consciousness. By changing the stage on which representations appear we can change the nature of the representations. This will allow new features of the unrepresented to appear in full consciousness (Steiner, 1912/1918). If this change is supported by a community of people who share the new state of consciousness, a new view of the world will emerge. This view will be based not on changed conceptions or on an enhancement of our current faculties but on the direct perception of aspects of the unrepresented that currently exist only in potential. By training our faculties we illuminate new aspects of the unrepresented much as we illumine items in a darkened room with a flashlight. As our consciousness changes, we enhance this ability. The aspects of the unrepresented that we perceived indistinctly now come before us more fully. It is as if we had opened the drapes and let sunlight stream in. We gain the ability to enter more fully into conscious interaction will the objects and beings in the room. A change in consciousness will bring about a transformation of science, not merely a revolution of our scientific conceptions (Kuhn, 1962).

A science based on a change in consciousness will be radically different from current science. However, like our current scientific world view, the new science will be dependent on a community to establish its validity. The community will establish the procedures of aperspectival objectivity that will support and validate its member's perceptions. It will be the vehicle for the manifestation of the new world view based on the change in consciousness.

To be effective in science a change in consciousness must involve a heightening of consciousness, not a diminution (Steiner, 1904/1947). By heightening I mean a state of consciousness that preserves the character of awakeness that is present in our daytime consciousness. Part of this awakeness is our consciousness of ourselves as an active participant

in events. This self-consciousness is in contrast to the lowered sense of self that we experience in dreaming. As self-consciousness actors we can become aware of our own contributions to the construction of our representations. Without this knowledge we could never be aware of our contributions and would have no chance of altering our representations. Becoming aware of our contributions can be a first step in altering our waking consciousness to allow the emergence of new aspects of the unrepresented.

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