POINTS EAST AND WEST: ACUPUNCTURE AND TEACHING THE CULTURAL CONTEXTS OF SCIENCE

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ABSTRACT. Acupuncture is a model case for teaching the cultural contexts of science. Acupuncture has been practiced in China for centuries, but American scientists were largely skeptical of its efficacy when exposed to it in the early 1970s. Chinese doctors explain the phenomenon using a conception of the body unfamiliar to Westerners. Western physiologists have in the past few decades been able to explain the startling analgesic effects of acupuncture in their own terms. But other elements remain explained only in the traditional Chinese system. By introducing the contrasting explanations and research practice, east and west, teachers can raise questions for students about the cultural contexts of science. More generally, cultural symmetry--the ability to invert cultural perspectives--is central to making any such case study more effective.

[In the conference presentation, this paper and a corresponding student module will be critiqued by Nancy Brickhouse (Univ. of Delaware) and Deborah Pomeroy (Beaver College). Please contact the author for information on the complete module.]

1. INTRODUCTION

Developing an appreciation of the cultural context of science can be challenging given prevailing conceptions of the nature of science. To convey context clearly, one wants vivid illustrations. Ideally, one also wants to show how the same topic can be approached scientifically in contrasting ways by different cultures. The history of acupuncture is ideal in both these respects. After framing the problem (§1), I discuss how to engage students in thinking about the cultural roots of scientific knowledge and scientific methodology by comparing traditional Chinese and Western approaches to acupuncture in the early 1970s (§§2-5) (see also Hagen, Allchin and Singer, 1996). In concluding, I address more general themes about cross-cultural case studies (§§6-7).

First, imagine yourself as an American physician visiting a Beijing hospital in 1971. A traditional Chinese doctor there tells you that they can alleviate pain by inserting needles at specific points in the skin and then twirling them slowly. The points are sometimes quite remote from the source of pain. Should you believe them?

Next, you witness a surgery where the main source of pain control is from a needle inserted in the patient's forearm. During the operation, the surgeon makes a 14-inch incision around the left side of the thorax, cuts two ribs, and removes a lobe of a tuberculosis-infected lung. Meanwhile, the patient--still conscious--chats with the surgeon. At the end of the 2-hour procedure, the patient sits up and leaves the operating table under his own power, brandishing a copy of Mao's "little red book." Is seeing believing? What did you see?

Finally, the doctor, who knows some Western medicine, explains that it is all quite reasonable if you understand traditional Chinese medicine. The needling, the doctor explains, redirects the flow of the life force through the body, balancing the potentially painful influence of the incision. Does the explanation affect the status of your belief? How? Why?

The use of needling as a form of medicine--a practice known as acupuncture--extends back for over 2000 years in China (Lu and Needham 1980). Acupuncture only received widespread exposure in the U.S., however, in the early 1970s when President Nixon began to reestablish U.S. diplomatic ties with the People's Republic of China. American physicians were at first largely baffled by how acupuncture could suppress pain. It followed no known physiological mechanisms. Indeed, it seemed contrary to scientific and common-sense notions about pain and the body in general. The Chinese explanation was incredible by their standards, but there was no satisfactory Western alternative. What would have been an appropriate 'scientific' response in 1971? This case poses penetrating questions for students, introducing them to the problems of science in two cultures.

2. CHINESE TRADITION AND WESTERN SKEPTICISM

In 1971, the U.S. was still basking in having landed the first man on the moon--perhaps the greatest technological feat of human history. An electronic microprocessor--a computer "chip"--had just been introduced. Texas Instruments had begun marketing the first pocket calculator. By contrast, China was the most populous nation on the globe, with one-quarter of the Earth's people crowded within its borders. China had a rich tradition of culture and basic technological discovery dating back thousands of years, but it was also largely a nation of peasants. This certainly provided a background for how Americans assessed reports from China.

The spectacle of surgery done under acupuncture startled many Western physicians. But Chinese doctors reported further that they used acupuncture to alleviate other sorts of pain as well, such as headaches, toothaches, lumbago, and chronic pain in joints and muscles. They inserted needles at different points specific for each treatment, as prescribed by their many centuries of experience. The Chinese even used needling to treat general ailments: hiccups, insomnia, asthma, muteness and blindness, ulcers, vitamin E deficiency and, more recently, drug addiction and smoking habits. That was quite an extraordinary list for such a modest procedure.

It is hardly surprising that some American doctors doubted the Chinese claims. For them, acupuncture was unscientific. They alleged fraud, suggesting that the "demonstrations" for Western physicians had been staged merely to promote China's communist regime. They warned of possible abuse

by "quackupuncturists". In fact, many acupuncture clinics that opened in the U.S.--and some that had existed previously in various Chinatowns in major U.S. cities--were soon closed by government authorities.

Only when U.S. doctors began to replicate the effects of acupuncture in American hospitals did such criticism abate. The historical case allows the teacher to introduce fundamental questions about how scientists judge the credibility of claims, especially indirectly through the credibility of other researchers. Western physicians were clearly accorded more authority than Chinese physicians. Why? In what ways were their judgments justified or unjustified? Students may best appreciate the problem by considering the Chinese perspective: how would a Chinese physician--credible among Chinese peers--have established credibility in a community of Western scientists? Who can be considered an expert about the effectiveness of acupuncture?

Many people acknowledged the positive effects for persons treated with acupuncture, but they were nonetheless unimpressed. Two reasons were given. First, in about one-third of all cases, a patient recovers from his or her condition even without treatment. For these cases, they argued, it would be inappropriate to credit acupuncture. The historical context of skepticism, here, provides an opportunity to underscore (in a constructivist style) the role of controlled experiments. In other words, students might well recognize on their own that to assess the effect of the needling alone, you would need to compare patients treated with acupuncture with those who received no treatment.

From a traditional Chinese perspective, however, the mere idea of such an experiment posed an ethical problem: why would you refrain from a treatment that your experience showed was effective? Chinese medicine stresses the result for the patient. Research is secondary. Therefore, you would not withhold a treatment just for the sake of a test. For the traditional Chinese, if you already knew *how* to help a patient recover, you did not also need to know *why* the procedure worked, especially if your research would likely cost patients their well-being. While a Chinese scientist might not disagree with the reasoning behind the design of the controlled experiment, it would be outside proper science. What is the boundary of science and can it vary culturally?

A second reason for disregarding acupuncture, according to some critics, was that pain might be suppressed merely through psychological suggestion--not a method worthy of serious medical attention. In other words, pain control might have resulted from some "unscientific" influence, such as hypnosis, not by the needling itself. In 1972 one doctor asserted, 'the "needlism" merely acts as a reinforcing stimulus as well as a diversionary maneuver to disguise the presence of a subtle placebo effect'. There was, he claimed, 'a misdirection of attention' (Kroger 1972).

Many Westerners were especially suspicious when they discovered that the Chinese tended to screen patients: not all were deemed eligible for acupuncture. Indeed, the Chinese had considered the attitude of the patient towards acupuncture as early as the Han period (2nd century B.C.). At the same time, Chinese doctors did not distinguish so sharply between psychological and physiological mechanisms. The treatment itself was effective. A Chinese doctor might have replied: is psychosomatic healing not healing? Chinese and Western standards for "good" medicine and science emphasized different values in this instance.

Of course, one could test for the effect of suggestion--and a teacher can invite students to design such a test. They might imagine, for example, that you could check acupuncture on a person or organism that can feel pain but that is not susceptible to suggestion. Both infants and animals, in fact, respond to acupuncture. Illustrations of acupuncture charts for horses, pigs, water buffalo, camels and other animals dating back to the Yuan period (14th century--before the European Renaissance) offer striking images of the Chinese tradition. Students might be able to interview local veterinarians who now use acupuncture (see Schoen 1994).

Another approach to testing suggestibility, commonly used in drug trials, is to prevent the patient from knowing whether he or she is receiving treatment. Some researchers have used "sham acupuncture", needling at non-acupuncture points. Others have used "treatments" of needles taped to the skin. Students may interpret the results themselves (reviewed in Pomeranz 1987). In various lab studies in the past few decades, acute pain stimuli (such as intense heat or sharp objects) were given to humans, mice, cats, horses, rats and rabbits. Needling of true points clearly suppressed pain, while needling of sham points produced very weak effects. In the case of chronic (long-lasting) pain, such as backaches or arthritis (studied clinically), results were more complex (the differences between groups are statistically significant):

	Effectiveness (patients' reports of pain relief)
sham acupuncture	33%-50%
placebos of needles taped to the skin	30%-35%
"true" acupuncture	55%-85%
morphine*	70%

(*Morphine has been accepted in the West as the most widely effective pain-killer. It serves as a comparison.)

Philosophers and sociologists have viewed 'organized skepticism' as a hallmark of (Western) science for some time (Merton 1942/1973). This case allows one to assess the role of such skepticism. What may have motivated such strong criticism and concerns about fraud in this case? Given the 2000-year tradition of practice in China, were additional tests warranted? In what ways, if any, did the early criticisms contribute to developing scientific knowledge? Students may consider how incentives or institutionalized checks and balances can either encourage or suppress such motivations. Teachers may invite them to devise a system that might positively regulate their effect.

3. PHYSIOLOGICAL EXPLANATIONS

While some American medical researchers regarded acupuncture as so much hocus-pocus, others were curious to know acupuncture might work. But the Chinese explanations were based on a fundamentally different, even incompatible 'geography' of the body (Moyers 1993). For the Chinese, the body is

maintained by a life force, *qi* (pronounced as a short, breathy 'chee'). The *qi* flows through the body along several intersecting meridians or channels. There are twelve primary meridians, each corresponding to a major organ (liver, stomach, spleen, gall bladder, etc.). They also corresponded to the twelve yearly cycles of the moon. The flow of *qi* along the meridians maintains a balance between *yin* and *yang*, the two complementary forces of the universe according to Chinese philosophy. Thus, some meridians or channels are *yin*, others *yang*.

The flow of *qi* along the meridians is how the Chinese traditionally explain health and illness. When the flow is impeded or imbalanced, disease, malfunction or pain results. To restore the balance, needles are inserted at points along the appropriate meridian. The needles either promote or impede the flow of *qi*, reestablishing the balance of *yin* and *yang*.

The concepts of *qi* and meridians are problematic from a Western perspective because no anatomical structures define the meridians, and no measurable force can be identified as *qi*. A Westerner may thus be inclined to think that the notions of meridians and *qi* are superfluous--perhaps relics of an ancient and discredited cosmology. But the concepts are essential from the perspective of actual practice. Acupuncturists use meridian maps to assess where needles should be placed. Indeed, part of the acupuncturist's skill is diagnosing which meridians have been affected and where along those meridians needles should be placed.

If the notions of *qi* and meridians have been unsatisfactory for Westerners, numerous studies over the past few decades have given them a more complete understanding in their own terms. Researchers found relatively quickly, for instance, that acupuncture for acute pain stimulates one particular kind of nerve. Most painful stimuli are carried along small fibers. Acupuncture, though, apparently stimulates larger fibers (type II and III muscle afferents). A theory proposed in 1965 suggested how the two nerve impulses might interact. The interaction was built on a mechanical analogy. According to the theory, there was a figurative 'gate' in the spinal cord where the two types of fibers converged. Only one impulse could be conveyed to the brain. As proposed, the large fiber would synapse with the small fibers, inhibit them, and prevent further impulses. This 'gate-control' theory could thus explain how gentle needling might "switch" off perceptions of pain--at least where nerves entered the same segment of the spinal cord.

Other researchers, however, noticed that the optimal effects of acupuncture often occur after several minutes--too slowly to be explained by nerve impulses. They wondered if there might be some factor in the blood. Again, students have the opportunity to propose or design possible experiments. In this case, researchers cross-linked the circulation of two rabbits through the veins in their legs. The acupuncture on one rabbit allowed the other to withstand stronger painful stimuli. Cross-injections of cerebral-spinal fluid also worked. They concluded that acupuncture triggered the release of an unknown hormone or similar "messenger" substance.

In 1973, researchers discovered accidentally that the brain releases a class of natural pain-relieving compounds similar to well-known opiate drugs, such as morphine. Among them was endorphin. Was endorphin involved in acupuncture, they wondered. They could study endorphin's possible effects using naloxone, a chemical that inhibited its action by blocking receptors on the cell surface. A 1976 study

addressed the effects of naloxone injected just prior to acupuncture in rabbits (see Pomeranz 1987, p.9):

Treatment			Pain Relief?
acupuncture			Y
acupuncture	+ naloxone		N
acupuncture	+ saline		Y
	naloxone	(no acupuncture)	N
	saline	(no acupuncture)	N
acupuncture at non-points		(sham acupuncture)	N
handling & restraint		(no acupuncture)	N

Again, students may interpret and discuss the results themselves, noting the role of each treatment in reaching their conclusions. How did the controlled experiment contribute to Western understanding here?

Western research on pain and acupuncture is far from complete, but the picture is becoming clearer. The system of interactions appears to be quite complex. The 'gate-control' theory, for example, now seems far too simple. Numerous nerves originating in the brain and ending at more peripheral points appear to inhibit the transmission of impulses towards the brain. Acupuncture activates many of these inhibitory systems at several levels. In quite different studies, acupuncture has also been linked to increased levels of cortisone, a steroid hormone released from the adrenal cortex. This suggests a link to immune responses. If confirmed, these might help explain acupuncture's other reported health effects in Western terms (Lu and Needham 1980; Pomeranz 1987; Baldry 1993; Liao et al 1994).

Explanation has been another feature typically used to characterize (Western) science (Hempel 1966; Kourany 1987; Boyd et al 1991; Salmon et al 1992). Again, the acupuncture case allows one to assess the precise role of explanation. Both Chinese and Western accounts present themselves as offering causal explanations. Both ostensibly match observations, though there are limits to what each can observe. Both have been revised through time. Although the Western account is well articulated and has been part of a deepening of knowledge about the perception of pain, it has not contributed to the practice of acupuncture. Western findings have yet to benefit or extend traditional treatment methods. An open question is: what have Western explanations achieved regarding acupuncture itself? In what ways are they important? If they are part of what makes science 'science', what is the role or significance of science in this case? Are there alternative ways to conceive 'science'?

It is worth noting that considerable Western research has been done by native scientists in China itself. Indeed, some of the experiments noted above were done even before the U.S. was introduced to acupuncture in 1971. At the same time, many Chinese have pursued research on the traditional explanations (e.g., Research Group... 1986). The Chinese, at least, do not seem stifled by the apparent contradictions in the two sets of explanations. More generally, the Chinese have adopted Western medicine, though not exclusively. Western and traditional Chinese systems exist side by side. One American acupuncturist trained in China noted, 'in China the idea is: they do not only give you Chinese

traditional medicine, because if you only learn Chinese traditional medicine, your mind will get stuck'. The posture of the Chinese towards the different explanations is itself an interesting feature to provoke student discussion.

4. GETTING TO THE POINT

The notion that an apparently painful stimulus might reduce pain was paradoxical enough for Americans. But even more puzzling for Westerners were the patterns of needling. Chinese doctors do not insert acupuncture needles haphazardly. There are specific points. Sometimes, the points are quite remote from the site of their intended effect. Thus, you might insert a needle between the thumb and forefinger (a well-known point called *ho-ku*) to treat either a headache or abdominal cramps(!). For coughing or a fever, you would use a point above the third toe. For Westerners, at least, the correlations made no anatomical sense.

The Chinese explanation for acupuncture, however, accounted for why the points and their effects could sometimes be so distant from each other. Because *qi* flows along meridians, needles inserted along one meridian may be effective anywhere along that meridian, even though they may be far from the place of the effect. Thus a needle at *ho-ku* can affect a headache or abdominal cramps because all lie on the 'large intestine' meridian.

Acupuncturists also use the notion of *qi* in inserting the needle. When needles are placed in the correct location, the patient usually feels a slight distension or numbness. The sensation is called *de qi*, or 'striking the *qi*', reflecting the view that the patient perceives how the flow of *qi* changes. Patients can sometimes also feel the numbness of *de qi* spread along the line of the meridian. Thus, even if the meridians and points have no Western anatomical "reality", they do have a basis in sense perception. And these perceptions guide treatment (or 'intervention' in Hacking's, 1983, terminology). For the practicing acupuncturist and the patient, at least, the traditional theory explains key observations.

Historically, acupuncturists learned exactly where the points were and how they were connected along meridians by experience. No one could predict, apparently, the sometimes zig-zagging pathways of the meridians--and there is no reason in the Chinese view why they follow the paths as now described. Instead, the meridian maps represent the collected wisdom of generations of acupuncturists.

Westerners could not explain the relationship of points in acupuncture. Not that they hadn't noticed similar phenomena. They were familiar, for example, with 'referred pain'. In these cases, pain from an injured internal organ was felt on the surface of the body, but not always near the organ. Perceptions generally occurred within segments of the body (or dermatones), however. They did not always match the sometimes distant separation of acupuncture points and their effects.

Westerners were also familiar with another set of points, discovered at the end of last century, that evoke pain when pressure is applied. These are now known as 'trigger points'. One physician claimed that sometimes pressure on these points can also alleviate pain. Researchers found in the 1970s that there is a strong correlation between the location of the trigger points of the West and the acupuncture points of

traditional Chinese medicine (Melzack et al 1977; Baldry 1993). But again, no one understands fully why trigger points produce pain, sometimes at specific locations remote from the point. In neither case--for trigger points or referred pain--is there an explanation in Western terms why these points might be related to pain relief.

The cross-cultural dimensions of acupuncture can be highlighted once again by new discoveries. In recent years, many points have been found that do not lie on traditional meridians. How would a Western skeptic likely interpret this fact? How might a Chinese doctor interpret the same fact? What can the paired interpretations reveal about the cultural context of science?

5. DISCOVERY AND PURSUIT OF RESEARCH

What is especially striking is that while Westerners tend to dismiss Chinese explanations, they nevertheless acknowledge that the Chinese discovered acupuncture. Chinese physicians, beginning almost two millennia ago, developed a thorough knowledge of a complex phenomenon that escaped the notice of Western inquiry in the three centuries since the Scientific Revolution. Growth of knowledge is another feature sometimes used to characterize science (e.g., Laudan 1977; Lakatos 1978; Chalmers 1990). In this view, discovery is as central to science as forms of justification. Novel findings, however, do not always emerge from laboratory studies or controlled experiments, other archetypal images of science. To the extent that discovery of new phenomena is a part of science, science in the Chinese culture on this occasion was somehow effective where science in the Western tradition was not: why?

Science is a process and the pursuit of research can be as significant as its results. Scientists cannot pursue every question, and so they make choices. In addition, their research involves equipment, human effort and time. They must decide where they will invest their limited resources. As noted above, for example, research on the clinical efficacy of acupuncture, even if based on skepticism, reflected at least some degree of commitment. Ultimately, the factors that can influence what research is done also help shape science itself. But which research is pursued, and why?

Chinese and American cultures offer very different contexts for the pursuit of research on acupuncture. Acupuncture is valued in China partly in an economic context. It is a relatively "low-tech" form of medicine. It requires little equipment, though it does require expertise and substantial training for the acupuncturist. It is a labor-intensive rather than capital-intensive form of medicine--especially appropriate to China. The Chinese have invested themselves in research on acupuncture. It was through a deliberate program of research in the late 1950s, in fact, that the Chinese first applied and then developed acupuncture as a form of analgesia for dental work and, subsequently, surgery.

The circumstances for acupuncture research in highly industrialized, capitalist nations are quite different. Because acupuncture involves no product to sell, drug companies and other investors have had little incentive to fund acupuncture research. There is no opportunity for profit. By contrast, research on endorphin-like molecules that may relieve pain and can be sold as a drug has been well funded. There are many ways to raise questions about pain, but funds exist disproportionately for those questions related to certain types of marketable pain relief. The prospect for knowing more about acupuncture thus depends

on certain sources of funding to support research--in this case, support for 'basic' research.

In addition, acupuncture in the U.S. is still widely viewed as an "alternative" or "folk" medicine. It has peripheral status. Many insurance companies and health plans, for example, do not pay for acupuncture treatments. Even Western doctors sympathetic to acupuncture often recommend it only when Western medicine fails or is *first* shown to be ineffective. Many practitioners and health administrators say that scientific assessments leave the efficacy and explanations of acupuncture still uncertain. They also continue to cite the potential for fraud (see, e.g., *Consumer Reports*, 1994). With the current commitments to Western medicine, the potential of acupuncture--and hence research on it--will be limited. What we know about acupuncture will be shaped, as it has in the past, by the research that is done.

6. CROSS-CULTURAL PERSPECTIVES AND CULTURAL SYMMETRY

The case of acupuncture effectively illustrates how one can open awareness of the cultural context of science, I think, because one can compare--and perhaps feel the tension between--two different cultural perspectives. First, it is possible to understand, and to appreciate independently, the perspective of each culture. In this case--as perhaps in most cases of cultural divergence in science--the contrast is especially striking because one must undergo a gestalt-like conceptual shift when moving from one culture's way of thinking to another's (Kuhn 1970). To see how one's own science may have a cultural context, one must be able to see it in comparison to science in another culture or see it as "strange" from the vantage point of a scientist in another culture.

Second, neither account of acupuncture conveniently reduces to the other. The Western accounts of nerve pathways and of endorphin offer powerful ways to relate acupuncture to other aspects of pain and physiology in general, precisely where traditional Chinese explanations remain silent. At the same time, the Chinese claim the original discovery; and they can explain the sensations of *de qi* and other details of clinical practice. Neither culture has "cornered the market" on explanations for acupuncture. In addition, the knowledge of each culture can be traced partly to the standards of scientific practice in each. This does *not* mean that all knowledge is "relative" and that there are no standards for reliable knowledge. It *does* mean that there can be different standards, each with effective means of accessing and representing the world. The aim is to highlight those multiple conclusions and multiple methods, and to explore their basis. The cultural tensions in the acupuncture case--far from being an awkward aside to universal science--offer the very kind of cognitive dissonance or discrepant episode that effectively motivates students to consider how and why science may be different in two cultural contexts.

A basic touchstone for an effective cultural case study in science, then, is whether it works symmetrically. That is, the example should be equally effective from each cultural perspective, or if the cultural perspective is reversed (Bloor 1976; Gieryn 1994). The acupuncture case, for example, properly framed, can pose as many questions in an Eastern classroom as in a Western one.

7. BEYOND ACUPUNCTURE

The reception of acupuncture in the United States in the early 1970s is only one case, of course. Other

cases have the potential to convey similar lessons about the contexts of science. For example, cross-cultural perspectives in medical science have become increasingly important recently. Many U.S. researchers are interested in medical treatments among cultures in non-industrialized nations (e.g., Cox and Balick 1994). Native practitioners (including the Chinese) often use plants that are not familiar to Westerners. Many drug companies are investing heavily to research whether indigenous herbal treatments can cure various diseases. Where effective, they want to look for their "active" chemical ingredients. Interest in the context of indigenous medicine, the explanations for various cures, or how they were discovered, on the other hand, is usually quite low. The practice of science here, as in the acupuncture case, invites discussion about the assumptions of Western science. For example, the search for single active ingredients reflects a reductionistic mode of investigation that disregards the possible role of multiple ingredients in combination or other aspects of the context in which the medicine may be prepared or administered. Treatments in non-Western healing systems are often more holistic and complex. They frequently reflect an implicit understanding of causation on several levels of organization simultaneously (physiological, psychological, familial, epidemiological, social). In such conditions, the whole methodology of isolating causes through controlled experiments is simply less effective because few background variables remain constant enough. Other forms of investigation and reasoning are more appropriate. Finally, the searching style of Westerners that is largely insensitive to context also reveals a culturally based strategy for discovery that may have certain biases.

Other topics lend themselves equally well to introducing questions about the cultural contexts of science: for example, archeaoastronomy (Williamson), ethnobotany (Sofowora 1985; Mshigeni 1991; Cox and Banack 1991; Arvigo and Balick 1993), metallurgy, agricultural systems (Ortloff 1988), and counting systems (Gerdes 1994) (see also Ronan 1982; Selin 1992; forthcoming; Thomas-Emeagwali 1993). Each exhibits cultural symmetry, properly framed. Through examples in these topics, students can view the effectiveness of scientific practice in two or more cultures. In exploring the sources of the differences, they will come to a deeper understanding of the role of cultural context in science.

REFERENCES

'Acupuncture', *Consumer Reports* **59** (Jan., 1994): 54-59.

Arvigo, R. and M. Balick: 1993, *Rainforest Remedies: 100 Healing Herbs of Belize*, Lotus Press (Twin Lakes, WI).

Baldry, P.E.: 1993, *Acupuncture, Trigger Points and Musculoskeletal Pain*. Churchill Livingstone (Edinburgh).

Bloor, David: 1976, *Knowledge and Social Imagery*, Routledge and Kegan Paul (Edinburgh).

Boyd, Richard, Philip Gasper and J.D. Trout, 1991, *The Philosophy of Science*, MIT Press (Cambridge, MA).

Chalmers, Alan: 1990, *Science and its Fabrication*, University of Minnesota Press.

Cox, Paul Alan and Michael J. Balick: 1994, 'The Ethnobotanical Approach to Drug Discovery', *Scientific American* 270(6, June): 82-87.

Cox, Paul A. and Sandra A. Banack: 1991, *Islands, Plants and Polynesians: An Introduction to Polynesian Ethnobotany*, Discorides Press.

Gerdes, Paulus: 1994, *Explorations in Ethnomathematics and Ethnoscience in Mozambique*, Instituto

Superior Pedagogico (Mozambique).
Gieryn, Thomas F.: 1994, 'Objectivity for These Times', *Perspectives on Science* 2:324-49.
Hacking, Ian: 1983, *Representing and Intervening*, Cambridge University Press.
Hagen, Joel, Douglas Allchin and Fred Singer: 1996, *Doing Biology: Historical Case Studies*, Harper-Collins (Glenview, IL).
Hempel, Carl: 1966, *Philosophy of Natural Science*, Prentice-Hall (Englewood Cliffs, NJ).
Kourany, Janet A.: 1987, *Scientific Knowledge: Basic Issues in the Philosophy of Science*, Wadsworth (Belmont CA).
Kroger, William S.: 1972, 'Hypnotism and Acupuncture', *JAMA* 220:1012-13.
Kuhn, Thomas S.: 1970, *The Structure of Scientific Revolutions*, 2d. ed., University of Chicago Press.
Lakatos, Imre: 1978, *The Methodology of Scientific Research Programmes*, Cambridge University Press.
Laudan, Larry: 1977, *Progress and Its Problems*, University of California Press.
Liao, Sung J., Matthew H.M. Lee and K.Y. Ng Lorenz: 1994, *Principles and Practice of Contemporary Acupuncture*, Marcel Dekker (New York).
Lu, Gwei-Djen and Joseph Needham: 1980, *Celestial Lancets: A History and Rationale of Acupuncture*, Cambridge University Press.
Melzack, Ronald, Dorothy M. Stillwell and Elisabeth J. Fox: 1977, 'Trigger Points and Acupuncture Points for Pain: Correlations and Implications', *Pain* 3:3-23.
Merton, Robert K.: 1942/1973, 'The Normative Structure of Science', in *The Sociology of Science*, University of Chicago Press (Chicago), pp. 267-78.
Moyers, Bill: 1993, 'The Mystery of Chi', in *Healing and the Mind*, Doubleday (New York), transcripted from video, Ambrose Video Publishing (New York, 1993).
Mshigeni, Keto: 1991, *Traditional Medicinal Plants*, Dar Es Salaam University Press (Dar Es Salaam, Tanzania).
Ortloff, Charles R.: 1988, 'Canal Builders of pre-Inca Peru', *Scientific American* 259(12, Dec.): 100-107.
Pomeranz, Bruce: 1987, 'Scientific Basis of Acupuncture', in *Acupuncture: Textbook and Atlas*, G. Stux and B. Pomeranz (eds.), Springer-Verlag (Berlin), pp. 1-34.
Research Group of Acupunture Anesthesia, Institute of Medicine and Pharmacology of Fujian Province: 1986, 'Studies of Phenomenon of Blocking Activities of Channels and Collaterals', in *Research on Acupuncture, Moxibustion and Acupuncture Anesthesia*, Science Press (Beijing) and Springer-Verlag (Berlin), pp. 653-67.
Ronan, Colin: 1982, *Science: Its History and Development Among the World's Cultures*, Facts-on-File (New York).
Salmon, Merrilee H. ... et al: 1992, *Introduction to the Philosophy of Science*, Prentice-Hall (Englewood Cliffs, NJ).
Schoen, A.M. (ed.): 1994, *Veterinary Acupuncture: Ancient Art to Modern Medicine*, American Veterinary Publications (Goleta, CA).
Selin, Helaine: 1992, *Science Across Cultures: An Annotated Bibliography of Books on Non-Western Science, Technology and Medicine*, Garland Publishing (New York).
Selin, Helaine (ed.): forthcoming, *Encyclopedia of the History of Science, Technology and Medicine in Non-Western Cultures*, Garland Publishing (New York).
Sofowora, Abayomi: 1985, *Medicinal Plants and Traditional Medicine in Africa*, Spectrum/John Wiley

(Ibadan).
Thomas-Emeagwali, Gloria: 1993, *African Systems of Science, Technology and Art*, Karnak (London).
Ulett, G.A.: 1982, *Principles and Practice of Physiologic Acupuncture*, Warren H. Green, Inc. (St. Louis).
Williamson, Ray A. (ed.): , *Archaeoastronomy in the Americas*, Center for Archaeoastronomy (College Park, MD).