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

Douglas Allchin
University of Minnesota
Minneapolis, Minnesota 55455 USA
allch001@umn.edu

Abstract. Acupuncture is a model case for teaching the cultural contexts of science. Acupuncture has been practiced in China for centuries, but American scientists expressed strong skepticism when introduced to it in the early 1970s, although the efficacy of many treatments has since been validated. Chinese and Western maps of the body and physiology are incommensurable. In addition, the styles of research and validating knowledge differ. By introducing the contrasting explanations and practice, east and west, teachers open questions for students about the cultural contexts of science.

When President Richard Nixon began to normalize U.S. relations with China in the early 1970s, the cultural exchange introduced the American public to the wonders of Chinese medicine, including acupuncture. Counterintuitively, needles seemed to suppress rather than induce pain.

Americans saw surgery with patients still conscious, the only analgesia provided by acupuncture. Some Western doctors alleged politically motivated fraud, or surgery patients beguiled under hypnosis — interpretations made more credible when patients brandished their copy of Mao's little red book. For them, it was "quackupuncture," not scientific medicine.

Still, the earliest reports were not easily dismissed. *New York Times* columnist James Reston reported his personal experience with acupuncture for pain following an emergency surgery in Beijing. His testimony carried some weight. American physicians visited China and saw the practice first hand. Not persuaded by millenia of experience in China, they tested it for themselves in the U.S.

Interpreting how acupuncture possibly worked posed further problems for Americans. Practitioners explained it using traditional Chinese concepts: by balancing yin and yang, and regulating the flow of *qi*, a transformative power not measurable with any *qi*-meter device. The conceptualization of physiology used a completely different map, or geography, of the body. Such concepts seemed to conflict with Western principles about nerve cells and immunology. What was an appropriate scientific explanation?

Finally, there was the question of the discovery and development of acupuncture, which seemed to have escaped Western science altogether. (Here, a 1601 manuscript shows different types of acupuncture needles for distinct purposes.) Could one view methods of Western science as any more effective than other forms of developing knowledge?

This historical encounter between East and West is an excellent opportunity for posing several questions about science, especially about its cultural context (a central theme of this Congress). It may also exemplify how science teachers may use such historical cases studies to guide students to reflect on scientific concepts, the nature of scientific knowledge and evidence, the process of science, and the nature of discovery and science in society. Students thereby develop a deeper and fuller understanding of science, as profiled in many current frameworks for science education reform.

I will focus on three themes in the acupuncture case, each illustrating how historical case studies may enrich science teaching. I will also comment on how one assembles such case studies. For example, acupuncture is (for most Westerners still) sensational. By fascinating students, one can engage their interest. Students are primed to participate in their own learning. Chinese students, I imagine, may be equally puzzled by how Americans responded. A further educational strategy is to also select drama that can lead directly to a significant principle in science, such as controlled experiment, the limits of evidence, or research ethics. In addition, one ideally finds a historical question or problem that can involve students in developing and practicing relevant thinking skills through discussion.

So, let our first target principle for the science classroom be skepticism and empirical testing. In this case, to what degree is acupuncture effective? How does one assess that? First, let's re-establish the historical context: In 1969, the U.S. had landed a man on the moon, perhaps the greatest technological feat of human history. In Texas, the first artifical heart patient lived for three days. By 1971, an electronic microprocessor--a computer "chip"--had just been introduced. Texas Instruments had begun marketing the first pocket calculator. American science seemed to prove its superiority. China, by contrast, although the most populous nation, was still largely agrarian. Its own history of technological achievements was obscure to most Americans, who tended to regard China, with its communist government, negatively.

So 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 and arthritis. They 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. One can imagine American physicians expressing measured doubt about such unfamiliar treatments.

Replication is relatively rare in science — except when claims are especially striking, important or controversial. This was one such occasion. Yet even after U.S. physicians demonstrated the phenomena for themselves, many remained unimpressed. Might acupuncture not fucntion merely through psychological suggestion? One doctor claimed that "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). Such critics noted that the Chinese tended to screen patients: not all were deemed eligible for acupuncture. Indeed, the Chinese had considered the attitude of the patient as early as the Han period (2nd century BCE). Practice seemed to betray inflated claims.

Of course, one could test for the effect of suggestion. Here is an opportunity to guide students in thinking experimentally and designing tests: an open-ended scientific problem presented in historical context. Students might tell you, for example, that you could check acupuncture on a person or organism that can feel pain but that is not susceptible to suggestion. Upon cue, the teacher may note that both infants and animals respond to acupuncture. Veterinary acupuncture is now well established. Illustrations of acupuncture charts for horses, pigs, water buffalo and even camels date back to the Yuan period, or 14th century.

One may also test suggestibility as is done commonly in drug trials. That is, do not let the patient know 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. Here, one may present historical results and coach students in interpreting them. One review article in 1987 noted unambiguous results for acute pain stimuli (such as intense heat or sharp objects) 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 pain, such as backaches or arthritis, results were more complex (Pomeranz 1987, 17). Allowing students to engage actual historical findings can help students learn skills, especially in interpreting more complex results.

"Organized skepticism" is frequently cited as a hallmark fo Western science. But this is also balanced against trusting the credibility of other researchers in a communal effort. How does one assess credibility? The case of acupuncture adds a notable cultural dimension, which may be probed through student discussion. For example, what may have motivated the strong initial criticism from U.S. physicians? Given the 2000-year tradition of practice in China, were additional tests warranted? How did the tradition become established and develop without double blind tests? Perhaps one needs to also consider the traditional Chinese perspective on assessing efficacy? By 1971 Chinese researchers were already conducting modern clinical studies, although typically published in Chinese. In what ways was Western skepticism justified or unjustified? How would a Chinese physician— credible among Chinese peers —have established credibility among Western scientists? Who was an expert about the effectiveness of acupuncture? Skepticism, testing and credibility are fundamental principles in the nature of science. Here, the historical case helps illustrate them concretely, while allowing students to develop skills in thinking about them.

Even with solid evidence about acupuncture's efficacy, Westerners were still puzzled. How did one *explain* acupuncture? How did needling suppress pain? In many cases needles were applied at locations quite remote from the area of their intended effect: why? Western researchers focused on the nervous system. They found relatively quickly that acupuncture for acute pain stimulates large nerve fibers. Most painful stimuli, however, travel along small fibers. A theory proposed earlier in 1965 suggested how the two nerve impulses might interact. The two types of fibers converge in the spinal cord. There, one impulse could possibly inhibit the other. This 'gate-control' theory could explain how gentle needling might "switch" off perceptions of pain— at least where nerves entered the same segment of the spinal cord.

Researchers noted later, however, that the optimal effects of acupuncture often occur after several minutes--too slowly to be explained by nerve impulses alone. They wondered if some factor might be released in the blood. Here again, students may be given the historical problem and asked to propose 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, not long after Nixon's visit and the wave of publicity on acupuncture, researchers discovered by chance that the brain releases a set of natural pain-relieving compounds: endorphins. Were they involved in acupuncture? One could study endorphins by inhibiting their action with a chemical called naloxone. Here is another set of original historic data from 1976:
The study addressed the effects of naloxone injected just prior to acupuncture in rabbits (see Pomeranz 1987, p.9). Students need to compare parallel treatments. They can thereby appreciate the strategy of isolating the effect of individual variables: the benchmark notion of controlled experiment. This example shows how controls help investigators check for possible errors in interpreting causes. Multiple controls may be needed to check for many possible errors. This is a good example of Western science — here, applied to ascertaining a role for endorphins in the phenomenon originally discovered by the Chinese.

Explaining acupuncture, like testing acupuncture, also has a profound cultural dimension. The Western account might easily eclipse the traditional Chinese explanation, the very framework of understanding under which acupuncture originally developed. Chinese explanations are based on a fundamentally different, even incompatible 'geography' of the body. For the Chinese, the body is maintained by a transformative force, *qi*. The *qi* flows through the body along several channels, or meridians: the *jing-luo* system. Twelve primary meridians each correspond to a major organ: liver, stomach, spleen, gall bladder, etc. These are organ functions, not necessarily the physical structures recognized in the West: hence the diagram here shows the meridians only, with the body itself almost invisible. The structure/function relationship so critical in Western biomedicine is absent here. *Qi* is all about function. When the flow of *qi* is deficient or imbalanced, health fails. Needles inserted at points along the appropriate meridian help either promote or impede the *qi*, and restore the balance of *yin* and *yang*.

Sometimes, the points are quite distant from the site of their intended effect. Thus, you might insert a needle between the thumb and forefinger, at a well-known point called *hegu* (also romanized as '*ho-ku*'), to treat either a headache or abdominal cramps! For coughing or a fever, you would use a point above the third toe. The *jing-luo* system explains why: they are on the same meridian. Thus *hegu* can affect the head or abdomen via the 'large intestine' meridian.

The concepts of *qi* and meridians are problematic from a Western perspective because no anatomical structures define the meridians or even the acupoints. *Qi* cannot be measured outside human perception. A Westerner may thus be inclined to abandon the notions as unnecessary — perhaps relics

of a once fruitful, but now antiquated 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. They 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, known as *de qi*, or 'striking the *qi*'. 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 seem to have a basis in sense perception. And these perceptions guide treatment. The *practice* of acupuncture would collapse without the *jing-luo* system. Western biomedical explanations are irrelevant.

Indeed, 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 the explanation is part of what makes science 'science', what is the role or significance of explanation in this case? Science seems to function differently in these two cultural contexts.

My third and last theme is the nature of scientific discovery. Perhaps the most penetrating question in the acupuncture case is: why did acupuncture develop in China, and yet escape attention during the same 2000 years in the West? Did a particular approach to science in China foster the unique discovery of acupuncture? —Or was it just historical happenstance?

The origins of acupuncture are uncertain, but the first texts that mention needling itself (some time between the eleventh and second century B.C.E., probably in the fifth century B.C.E.) do not refer to *qi*. The earliest explicit mention of the *qi* channels (second century B.C.E.), by contrast, are primarily in the context of moxibustion, a related practice in which dried leaves are burned on the skin at points now used for acupuncture. The use of needling appears to have been grafted onto this earlier practice. Cosmology entered still later, in the 3rd century of the Common Era. 365 points were identified, corresponding to the days of the year, and they were organized into twelve meridians, for the annual lunar cycles. The notion of channels might have been inspired, of course, by the sensations that spread over the surface of the body during treatment at certain points (see Cooperative Group 1980). No cosmological reasons, at least, dictate the *specific* meridian pathways, which sometimes take abrupt turns, or zig-zag their way, say, around the side of the head. The cosmological framework, while present, did not trump raw observation. The meridian point-maps were derived empirically, or perhaps semi-empirically.

The cosmology (or "theory"?) of the formalized *jing-luo* system did not preclude the discovery of additional acupuncture points that did not fit that particular framework. In subsequent centuries, and even in the past few decades, other needling points were added, sometimes along with new "collateral" channels. What mattered primarily was performance.

One might well imagine that the elaborate cosmological conceptions of acupuncture limited free invention or discovery. However, acupuncture analgesia is a recent discovery. As part of Mao's

"Great Leap Forward," researchers were urged to rely on the strengths of traditional Chinese medicine and develop them further. In 1958, doctors at a Shanghai hospital imagined that acupuncture-— used for centuries to control chronic pain— might also be applied to short-term pain. They first tested needling on pain relief while changing surgical dressings. They then tried tonsillectomies and, finally, major surgery. Thus, U.S. physicians amazed by acupuncture analgesia a mere decade and a half later were witnessing a relatively new variation of a centuries-old practice. The discovery was clearly motivated by deliberate search, but not by theory. The search was also politically "inspired," although hardly expressing ideological bias. Perhaps the patients were justified in proudly waving their books of quotations from Chairman Mao?

The history of acupuncture is thus somewhat haphazard—perhaps like some of the zig-zag meridian pathways! Yet the series of discoveries strongly reflect Chinese patterns of thinking. Chinese philosophies highlight particulars and their relationships, rather than the abstract generalizations more common in Western philosophy and science (Hall and Ames, Kaputchuk). By orienting to details, relatively indifferent to developing a "theory," did Chinese perspectives foster discovery of acupuncture points, their connections and noticing the relationship between needling and moxibustion? When new points did not fit the jingluo system, they did not reject that theory, nor generate an alternative paradigm. Students may discuss: was that unscientific reasoning, or a nuanced form of pragmatism? The success of the Chinese discovery of acupuncture is a puzzle.

The Chinese history contrasts with corresponding discoveries in the West. At the end of the 19th century, Westerners independently found a set of points that evoke pain when pressure is applied, now known as 'trigger points'. In the 1970s the locations of trigger points and acupuncture points were strongly correlated (Melzack et al 1977; Baldry 1993). While the discoveries seem similar, trigger points were never linked together, and they remain largely unexplained. Nor have trigger points been incorporated into medical treatments. In the West, trigger points—possibly the same as acupoints—have remained peripheral.

In addition, acupuncture itself has found its way to the West on several occasions in the last four centuries (Skrabanek 1985; Liao, Lee & Ng 1994). Yet despite these repeated opportunities, Western science failed to establish an enduring field of research or sustained practice prior to the 1970s. For example, Wilhelm ten-Rhyne (Rhijne) wrote of it in 1683, prompting a thread of research in Germany and France (including by Kempfer and Vicq-d'Azyr) in the 18th century. Berloiz (1816) eventually found that galvanic stimulation of needles was effective. But when galvinism apparently did not explain the phenomenon fully, pursuit faded (Pellerton 1825). James Churchill, of the Royal College of Surgeons, echoed earlier advocates again in 1821, while acknowledging that:

> if . . . a rational theory, built on sound logical reasoning, be the only evidence to which any value can be attached, then will my efforts have been unavailing and fruitless. (Churchill 1821, pp. 3-4)

Popular interest rose briefly, then, just as quickly waned, perhaps for the reasons Churchill mentioned (*Medico-Chirugical Review*, 1829). It was revived yet again in 1939 by French diplomat Charles George Soulie de Morant (1938/39). Despite numerous encounters with acupuncture, Western science failed to adopt it or to develop earlier Chinese discoveries. Given, such missed opportunities,

can Western science posture itself as adopting optimal or exclusive methods for generating natural knowledge? Are these methods universal? That is, do they transcend particular cultures? In the case of acupuncture, Chinese approaches seem to be different— and more fruitful. With this information, students are primed to discuss: in what ways might acupuncture reveal a cultural context to the process of science?

Chinese and American cultures continue to offer very different social contexts for the pursuit of research. Acupuncture became highly valued in China partly in an economically. It is relatively "low-tech". It requires little equipment. Effective practitioners, however, require substantial training. Acupuncture is labor-intensive rather than capital-intensive — appropriate to a densely populated nation. China has invested considerably in research on acupuncture, exemplified in the program of research in the late 1950s. 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 little opportunity for profit. By contrast, research on pharmaceuticals that may relieve pain and can be sold has been well funded. There are many ways to raise questions about pain, but in industrialized culures, funds exist disproportionately for those questions related to marketable forms of 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 199-, acupunture received the partial endorsement (for some treatments) from an NIH Consensus Panel. Still, acupuncture is still widely viewed in the U.S. as an "alternative" 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. 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.

That, then, is a concise historical comparison of Western and Chinese accounts of acupuncture. Neither conveniently reduces to the other. The Western accounts of nerve pathways and endorphins 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 made the original discovery; they explain the sensations of *de qi* and guide effective clinical practice. In addition, the complementary knowledge contributed by Chinese and Western traditions reflects how scientific practice differs in the two cultural contexts: the primary aim of assembling this particular case study.

I also hope this case may serve as an example for how to assemble historical case studies. An effective case study, in my experience, first engages students with spectacle and uses the drama to lead them to questions and problems that reflect major principles about scientific practice — experimental design, scientific communication, political contexts, etc. Students then develop thinking skills by working through unresolved historical situations in discussion, often learning from others how to view the same case differently. The history provides concrete details. Complexity, so typical of real cases, may

unfold as students are ready for deeper levels of understanding. The ultimate historical outcome may help in closing the case. The educator's primary challenge is to find the historical dilemmas that can motivate students. Another challenge is to frame the context for discussion, laying a foundation for free, open-ended interpretation. Developing thinking skills and perspectives about the nature of science involves going beyond lectures of teacher-specified content. Deeper lessons emerge from engaging students in real problems on a manageable scale. That is the value and source of excitement in teaching through historical case studies.

References

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