Imagining the Brain

Episodes in the History of Brain Research

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CHAPTER 8

Pinpricks: Needling, numbness, and temporalities of pain

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Abstract

Acupuncture analgesia appeared relatively straightforward. A patient laid awake as the practitioner needled selected sites on the body to induce numbness for surgery. Numerous reports emerging from China in the 1970s featured men and women resting on operating tables, smiling into the camera, surrounded by doctors who attended to the excised region—the esophagus, brain, gut, heart, or lungs. In the course of a decade, hundreds of news articles proclaimed acupuncture analgesia as embodying the spirit of Communist politics. While “acupuncture analgesia” was a heterogeneous practice that addressed a variety of disorders, it cohered visually in photographs of patients indifferent to their vivisected bodies, and it cohered discursively as a means for eliminating sensitivity to pain. Across these domains of representation, I argue that reports of obliterating pain with a single needle across clinical encounters collapsed the multiple temporalities of pain. Drawing on sources from an imagined community of researchers and physicians in parts of China, Singapore, Macau, Hong Kong, Britain, and the United States, this chapter explores the epistemic and ontological implications of numbness—a distinct sensation defined by the lack of sensation—in the absence of the brain.

Keywords

Acupuncture analgesia, Numbness, Surgery, Pain

Huang Kan-fah was nervous. He laid on the operation table surrounded by strangers. A group of non-medical staff entered the room and stared at the swollen thyroid bulging from his neck. “I could see that the artery under the skin was pulsating up and down quite fast,” wrote an observer (Wong, 1972, 42). At one end of the table, a young anesthetist cradled Huang’s head. She inserted a needle between his thumb and index finger and pressed longer needles into other parts of his body. With the needles in place, she strung a thin wire from each site to a small white box that generated quick, pulsating vibrations. She measured Huang’s heart rate and blood
pressure, and when he stabilized, the surgeons were ready to operate. She lowered her head and whispered to him. Huang, still awake, looked up with a sheet partially covering his face, unaware that the surgeon had started dragging a scalpel below the jaw. Blood seeped from the opening, and, displacing wet sinew, the surgeon reached in.

Huang blinked. He began to relax and smiled at the anesthetist. She turned to the stunned visitors and suggested that they talk to Huang. One visitor approached. “May I take your picture when you are smiling?” he asked. “Certainly,” replied Huang, “Go ahead” (Wong, 1972, 42) (Fig. 1).

Huang understood the rules of the stage. He posed for the witnesses who expected to see “something strange” (Wong, 1972, 42). The surgeons were the experts and Huang was the subject. Meanwhile, the anesthetist managed the stage: she applied the needles, she monitored Huang’s breathing and pulse, she guarded his head, she invited the strangers to approach him. The entire event was orchestrated, but not unreal.

FIG. 1
Huang Kan-fah during his thyroid operation.

This chapter explores representations of numbness in the 1960s and 1970s through surgical operations performed under “acupuncture anesthesia.” Translated from *zhenjiu mazui*, “acupuncture anesthesia” did not induce general anesthesia but had specific effects on sensation. In the operation room, it eliminated feelings of pain often without the aid of chemical anesthetics. In the clinic, it relieved long term chronic disorders. In textbooks, it treated paralysis, asthma, heart disease, high blood pressure, and nausea.

Needling involved numerous applications of numbness. And across these encounters were numerous forms of pain. Causes from within—old lesions, rotting molars, herniated discs—to causes from without—dentist drills, scalpel blades, surgical saws—each competed with a small collection of needling sites. These needles were sometimes large, sometimes small; sometimes connected to a battery-powered box, sometimes manipulated by hand. In the clinic, they either relieved or prevented pain. However straightforward, the range of possibilities made it difficult for physiologists to generalize how needling worked, even when it often did. Even worse, trying to articulate the mechanics of “acupuncture analgesia” conflicted with emerging theories of sensation in the 1960s. Neurophysiologists relied on metaphors of gate-controlled centers at the spine—gates that opened to allow some sensations to reach the brain, while denying the passage of others. Because patients were awake during surgical operations, psychologists suggested that needling both induced specific brain states and activated particular neuronal circuits that mediated pain. In other words, needling made use of and bypassed gates at the spine. And yet, these theories could not account for the range of therapeutic effects that needling initiated. Needling not only obliterated pain, but also redirected attention.

Beyond the operation room, needling could also mitigate drug addiction—it counteracted desire and dependency. Building on reports of acupuncture analgesia, physicians also used needling to help with smoking cessation and ease patients off prescribed medication. The effects of analgesia seemed simple enough, and physiologists used numbness to explain needling—that it eliminated pain and desire because of its ability to selectively act on seemingly discrete categories of sensation and attention. But its effects could linger over time long after the initial point of contact. These competing methods of removing, replacing, and reinforcing sensation relied on multiple temporalities. Performing the effects of needling in the operation room demonstrated its immediate effects. Practicing needling in the clinic manifested its long-term consequences. Yet the more physiologists relied on the curious effects of numbness to explain needling, the harder it was to define which aspects of numbness could be applied to needling in full.

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1 Facing facts

Performing “acupuncture analgesia” was a political endeavor. Imperial bureaucracies in the nineteenth century had banned apparently crude practices like acupuncture and moxibustion (needling and cauterizing techniques) in favor of the more
complex and sophisticated methods of deploying *materia medica*. But with mounting anxieties of modernity at the turn of the twentieth century, socially-engaged physicians in China reinvigorated needling and cauterization as effective, inexpensive, and accessible modes of medical training and health care delivery (Andrews, 2015). Reinterpreting classical texts made needling uniquely “Chinese,” while the technologies of care, including moxa sticks and needles, aligned with a political discourse of mimicking and surpassing “Western” doctors who trained at well-funded institutions.

Physicians allied with the Nationalist and Communist regimes each produced new collections of textbooks and diagrams to articulate a distinct vision of the body. But with devastation of civil war, famine, and social upheaval, governmentsponsored political campaigns continued to invent and re-invent standards of “Chinese” medicine over the course of several decades. By the 1960s, this reinvention was particularly instrumental during the Cultural Revolution (1966–1976), another violent period of social upheaval that involved a complex combination of anarchy and dictatorship (MacFarquhar and Schoenhals, 2006). Over a decade, mass parades publicly humiliated, abused, tortured, and imprisoned hundreds of thousands of politicians, scientists, intellectuals, and civilians (Esherick et al., 2006). Under these circumstances, needling became part of a militarized movement that embodied and enacted revolutionary ideology that was at once tied to Cultural Revolution propaganda with real impact on real lives (Mittler, 2008, 469). Reading accounts like those about Huang at the opening of this chapter allows us to further recognize the literary devices in acupuncture analgesia reports that shaped the epistemic and ontological debates about the nature of needling and numbness.

While “acupuncture analgesia” remained a heterogenous practice, it visually cohered in a series of photographs of patients in the operating room. Numerous publications featured surgeons attending to the exposed esophagus, brain, gut, heart, and lungs. At the center of these photos was the patient’s face. Whether bemused or indifferent, expressions showed that the patients were awake, that they could give consent, that they could talk and negotiate. In short, they had agency to return their gaze in the medical arena. Though their range of vision was partially obscured by a white sheet, they observed the physicians around them. Patients like Huang followed the movements of the surrounding physicians with his eyes, forcing the medical staff to in turn alter how they behaved in the room. Walking too quickly or speaking too loudly would excite the patient and unintentionally increase his blood pressure. The patient’s face then did more than gauge the efficacy of the needling. These faces determined the terms on which needling occurred. They showed that analgesia worked, but only following a careful choreography of bodies (Figs. 2–4).

If we consider reports that relayed events like Huang’s surgery with caution and with care, we can then appreciate how the photograph of a smiling patient indicated a particular kind of performance. The face demanded a certain kind of attention to context, history, and individual vulnerability. But this attention also obscured equally complicated physiological questions about how needling induced analgesia at different depths in the body and at different distances. Needling was also used for different types of pain, which were pre-operative, operative, and postoperative. Some of the
pain was chronic, some of the pain was acute, some of the pain was induced externally, some of the pain was vaguely distributed.

Inducing numbness at different depths in the body also induced numbness within different types of tissues. Early reports of acupuncture analgesia took place in tuberculosis research hospitals that specialized on the chest cavity. One famous case that featured a patient named Hu Shu-hsuan demonstrated how applying needles to his ears both allowed surgeons to cut into his chest, remove scar tissue, saw through his ribs, collapse his lungs, drain his pus, and extract a fistula. This was a messy operation. But the elimination of feeling from cutting, breaking, and pealing was so absolute that Hu was not bothered when he heard the sound of his own bones cracking. When surgeons asked how he felt, Hu had said, “I am feeling fine, not a bit of pain. Please go on.” He also described feeling some “scratching,” but no pain (Lee, 1971, 2; “A Small Needle Works Wonders,” 1972, 8). In a previous operation in which Hu had undergone general anesthesia, he choked on his own phlegm and surgeons had to cut open his trachea. Now on his twenty-fifth operation, he was too weak to for general anesthesia, which would have led to heart failure.
In contrast to the photo of a smiling face and reports of “feeling fine,” the sources of pain that needling prevented occurred at different depths and accumulated over time. Bones had nerves, muscles had nerves, and nerves wrapped around capillaries. When these soft and solid tissues tore or fractured, new injuries introduced new sources of pain. Other patient reports involved the use of needles to reduce the pain of a fractured femur. In these cases, the source of pain was introduced long before the needle was applied. For instance, in one of the most famous cases, James Reston (1909–1995), then vice president of the New York Times, had popularized “acupuncture anesthesia” as a means for relieving immediate postoperative pain. While in China, he underwent an emergency appendectomy and recalled how the physician inserted three thin, long needles in the outer area of his right elbow and knees, manipulating them to relieve pain in his gut. The physician twirled the needles on his body, before lighting two sticks of moxa to heat his abdomen. Reston wrote,

*That sent ripples of pain racing through my limbs and, at least, had the effect of diverting my attention from the distress in my stomach... All this took about 20 minutes, during which I remember thinking that it was rather a complicated way to get rid of gas in the stomach, but there was a noticeable relaxation of the pressure and distension within an hour and no recurrence of the problem thereafter.*

Reston (1971, 6)
What Reston observed as “gas in the stomach” registered differently to the medical practitioner. Needles had sent ripples “racing” through his body. The sensation that ended up “diverting” his attention lasted for 20 min. These overlapping temporalities of different causes of pain, from his inflamed appendix to his surgical lesions, accumulated in his gut. But within 20 min of heating and needling, this discomfort dispelled. And whether used for maintaining blood pressure, preventing shock, or relieving postoperative pain, at stake in the expansive category of “acupuncture anesthesia,” was the careful selection of needling sites. To work, they had to be stimulated for the right amount of time before providing pain relief and pain prevention.

These needling techniques were not new. Historically, classical literature frequently described the different ways in which needling could address chronic and acute pain. Some sources cited techniques of using acupuncture to relieve pain—including migraines, toothaches, and more—in the eleventh century and potentially as early as the first century (Lu and Needham, 1980, 115). But by the twentieth century...
century, using the language of “anesthesia” allowed physicians to re-introduce needling in the mid-twentieth century as something new, something Chinese, and something Communist. Rather than engaging with the already long history of needling and pain relief, the Peking Tuberculosis Research Institute reported their process of first performing chest surgery with needling as a true novelty in 1965.

Yet, their attempts were not the first. Members of the Beijing surgical team had traveled to the First General Tuberculosis Hospital in Shanghai after hearing reports of successfully needling to remove parts of the lung. Surgeons there experimented with needling while draining excess fluid from the chest, with limited success. Meanwhile, the Beijing team likewise experimented with finding new sites. Hsin Yu-Ling, the head of a surgical department, explained how his team initially began with needling forty sites. From forty, they reduced the sites to thirty-two, keeping morphine on hand in case the patient felt pain. Then they gradually reduced from forty to a single site to use depending on the type of surgery. Over the course of seven years, they performed over six hundred operations with needling, among which over two hundred operations that used a single needle to induce analgesia, reporting around a 98% success rate (Hsin, 1973, 18).

The Shanghai Acupuncture Anesthesia Cooperative, which had been using needling in surgery since the 1950s, described another set of operations in which they specialized:

*Under acupuncture anesthesia, we shot up the patient’s cranium and removed a decidual sarcoma as large as a bowl; lift [sic] the chest cavity and cut off the diseased lung; extend the finger into the heart vein and lift the narrow mitral valve; cut up the abdominal cavity and remove the malignant neoplasm of the nest with more than 40 kilos of weight.*

*Shanghai Acupuncture Anesthesia Cooperative Group (1972, 59)*

An early proponent of “acupuncture anesthesia,” the eye-nose-throat specialist in the Cooperative Group had first used needling for removing tonsils. She observed that a tonsillectomy under general anesthesia had various side effects, such as difficulty swallowing and eating after the surgery. The pain from the surgery lingered. But performing the surgery under needling-induced analgesia diminished the subsequent inflammation. They were not the first to do so either. In the 1960s, the Shanghai surgeons had learned needling techniques from a Guangxi group that experimented with different techniques during lung surgery. After two hundred operations, the Shanghai group developed their own selection of needling sites (Shanghai Acupuncture Anesthesia Cooperative Group, 1972, 60). They observed the analgesic effects of twenty-nine sites on six hundred patients and collected over forty-thousand data points. The most robust sites reduced to three, four, and one to two sites (Shanghai Acupuncture Anesthesia Cooperative Group, 1972, 62).

The surgical applications of needling were highly experimental, but not unique to individual medical institutions in China. For instance, the Chinese Academy for Research in Traditional Chinese Medicine reported around five hundred thousand operations performed under some form of needling (Needham, 1972, 118). Another
official report described over four hundred thousand cases of patients undergoing surgery with “acupuncture anesthesia,” which was used on infants and the elderly with a 90% success rate. Another commune in Jiangsu reported over twenty different kinds of operations under needling around the ears and nose (Lee, 1971, 3). Among these reports, the success of the anesthesia often depended on the type of surgery, the patient’s condition, and the needling sites. Abdominal operations were considerably difficult to anesthetize with needling alone, and surgeons in Guangzhou often supplemented anesthetic effects with a relaxing agent or resorted to chemical anesthesia (Needham, 1972, 137). Surgeons in Beijing explained that they selected their needling sites by beginning with twenty-one different sites before realizing that fewer points were more effective and reduced their points to around three. “You get cancellation effects,” they said (Needham, 1972, 139).

Beyond the selection of a needling site, more important was its “induction time,” or how long the needle was left in the skin to induce the appropriate analgesic effects (People’s Liberation Army Hospital, 1972, 70). The relationship between temporality and efficacy was not unique to cases of “acupuncture analgesia” alone, but to needling more generally. Identifying the active needling site required the patient and the physician to recognize a specific sequence of sensations. Echoing classical medical texts, physicians described a particular feeling known as deqi where the patient would feel “acidity, bloating, heaviness, and hemp” and the physician would feel the needle being “lightly ‘sucked’” (Shanghai Acupuncture Anesthesia Cooperative Group, 1972, 62).

Not all areas on the body responded to needling in the same way. Medical workers at institutions that specialized in tuberculosis appreciated the effects of needling because the chest responded well to single-needle analgesia, unlike other areas. “A single needle for chest surgery has many good points,” explained Hsin Yu-Ling, the department head. But the needling efficacy had its limits as the surgery progressed and complications arose after the chest was cut opened. An exposed cavity sometimes caused incomplete analgesia and the patient found it difficult to breathe normally (Hsin, 1973, 18). Different disease states, forms of abscess, and types of tumor each demanded different approaches. Even the idea of having “cancellation effects” among needling sites reinforced the idea of individual paths extending across the length of the body that were corporeal enough to come into conflict. Practitioners would re-orient their intended paths of intervention. Some would apply needles contralaterally, on the opposite side of the intended area of incision, or experiment by placing needles on the same side of the body.

2 Measurement and metaphor

Individual sites were not active all the time. Still, popular accounts of needling at nerves featured attempts to identify needling sites using devices that induced and detected skin conductance in any body, during any time of day, and under any condition. The physician Han Suyin (1916–2012), who was initially skeptical that these machines could detect needling sites, described her experience when scientists
measured particular sites on her skin. To her surprise, she noticed that some areas registered different responses than others. “The electrical potential was higher and more varied than that of the surrounding tissue,” she wrote (Han, 1964, 8). Her collaborators explained that the electrical potential on the skin could be influenced by physiological processes and emotional states. Suspending her disbelief, she wrote,

Unbelieving, I held out my hand, compared it with the chart, and asked that the “acupuncture point” between the thumb and the index finger (supposed to lead along one of the 12 meridians to a part of the large intestine) be tested. The point electrode was applied to the exact point, and the needle jumped, showing a bio-electric charge. A few millimeters away from the precise spot my skin was electrically inert. I tried many other points on my body, referring to the model, and felt mystified…

Han (1964, 8)

To Han, this experience suggested that sites could be located and measured using an electrical current, and that the electrical currents reflected the electrical characteristic of needling sites. She further suggested that the electric probe responded to areas on the skin that exhibited different levels of “bio-electric” charge, and these sites could be located based on prior knowledge of the sites. But even as Han tried to make sense whether the electric probe found, confirmed, or clarified the existence and substance of needling sites, she was still not fully convinced that probing at the skin gave a complete picture.

While electric probes measured conduction at the surface of the skin, these measurements failed to register the varying depths of needling sites. When asked whether therapeutic effects were treated through the “flow of electricity,” one physician in Vietnam explained to a visiting American cardiologist that it was instead the “flow of energy from a high-energy level to a low-energy level, not a flow of electricity” (Dimond, 1965, 575). Rather than reducing the efficacy of needling sites to the electric conductivity of the skin, the physician instead referenced classical texts that represented the body as a series of “conduits.” These therapeutic effects had “nothing to do with the circulation of the blood or the nervous system,” the physician explained (Dimond, 1965, 575). Instead, channels, tracts, or meridians that connected different parts of the body at different depths explained how a single needle under the manubrium and sternum could treat asthma, how stimulating sites inside the wrist could treat liver-related high blood pressure, how sites on the left toe could treat forms of heart disease. Needling effects extended beyond the electrical currents of the nervous systems.

Probes that registered electrical currents only revealed a partial perspective of the body. Still, another metaphor entered needling vocabulary in the form of “gates.” In 1965, physiologists Ronald Melzack and Patrick Wall published titled “Pain Mechanism: A New Theory” that attributed pain perception to controls in the central nervous system. Sensation remained a complex problem among neurophysiologists who argued for and against specialized networks of pain. While some neurophysiologists insisted that pain operated on an independent network, others
argued that pain induced impulse patterns in non-specific receptors (Melzack and Wall, 1965, 971). Still, neither of these camps could account for the inconsistencies of pain perception. For instance, nerve lesions did not always induce pain, and when nerve lesions did hurt, the pain was not continuous (Katz and Rosenbloom, 2015).

Melzack and Wall’s theory aimed to be dynamic. The metaphor of “gates” was a powerful one. Gates could open wide. Gates could open partially. Gates could be controlled—they regulated for speed, for intensity, for fluctuation. And indeed, when Ronald Melzack reflected on the theory itself, he explained that the “gatelike mechanisms” at different centers in the body were shifting and changing. Building on this metaphor, he wrote,

The gates can be opened or closed to varying degrees by nerve impulses in the larger- and smaller-diameter fibers in each sensory nerve running from the body’s surface to the spine and the brain. Activity in large fibers tends to close gates and lessen the pain, while small-fiber activity tends to open gates and increase pain. Activity in the fibers that descend from the brain stem reticular formation, which coordinates information from the sense organs and various parts of the brain, can also open or close gates. This part of the nervous system received impulses from all the sensory systems as well as other brain areas. It normally keeps the gates partially closed, but it can close them entirely or open them wide. Fibers from the cortex of the brain—the center of the memory, attention, anxiety, and interpretive functions—also can either open or close gates.

Melzack (1975, 65–66)

For Melzack, gates were dynamic structures that responded to differently-sized fibers in the body and to memory, attention, and emotion. These “impulses” extended from material manifestations of being, thinking, and remembering. To be sure, the metaphor of sensory “gates” was not universally received. Melzack and Wall’s paper attracted a handful of citations in the first ten years following publication, but in the mid 1970s, their, perhaps partially infamous, popularity increased tenfold by the 1980s with over one thousand citations (Katz and Rosenbloom, 2015).

The sudden burst of interest in gate control theory was not incidental. In the early 1970s, Ronald Melzack also started reading reports from China on the analgesic effects of needling. He collected reports of British physicians who traveled to Shanghai and watched surgeons remove a patient’s entire lung under the effect of a single needle. Melzack was amazed that the patient had only felt “an occasional pulling sensation,” even though this sensation might have changed over the course of the surgery (Melzack, 1975, 58). He noted that Shanghai physiologists observed the ways in which registered pain responses in the spine and the brain vanished once needles were applied. “This confirms the belief that acupuncture works on pain through known pathways in the central nervous system,” Melzack wrote (Melzack, 1975, 60).

Needle-induced-numbness offered a material foundation for gate-control theory. In addition to structural fibers, memories, and emotions that operated on different “gates,” the numbing effects of needles brought together the mechanical actions of the fibers and the material effects of the emotions. When a series of needles
entered and twirled in the body, they potentially “triggered” these gates. But such effects were not limited to needling alone. “Support from the gate-control theory has come from electrical stimulating devises,” Melzack added, describing how small battery-powered boxes with extending electrodes could also be used to relieve pain (Melzack, 1975, 67). These nameless devices, like the machines that detected skin conductance or sent vibrating currents to surgical needles, registered on the skin. Yet, the exact placement of the electrode relied on a different epistemic impetus and political construction of knowledge.

While gate-control theory implied a universalizing perspective of pain, the therapeutic aspects of needling did not carry a similar impulse. Some American physicians who picked up on the social, cultural, and psychological experiences of pain warned that needling had to be thoroughly tested on American bodies before accepting it as a standard form of treatment (Dimond, 1971, 1563). The “psychological factors” that potentially influenced pain perception also potentially reinforced biological and cultural differences among bodies. In other words, “Chinese” needles could only work on “Chinese” bodies—even when the techniques had long traveled beyond the nation-state and developed as different forms of practices by physicians in Hanoi, Tokyo, and Seoul. Furthermore, proponents of gate-control theory and therapeutic needling recognized the role of the individual. Both acknowledge that idiosyncratic bodies and idiosyncratic experiences generated idiosyncratic responses to stimuli. “[P]sychological factors such as past experience, attention, and emotion influence pain response and perception by acting on the gate control system,” Melzack and Wall wrote (Melzack and Wall, 1965, 977).

3 Mediating agency and materiality

It was not that Chinese bodies were different from non-Chinese bodies. Rather, the political conditions under which needling occurred differed. Both in China and elsewhere, people measured electric currents on their own bodies; they tested the effects of needling on themselves. Only “acupuncture anesthesia” in China was cast as a both political movement and medical miracle. An article in *Eastern Horizon* celebrated it for exemplifying the potential of a classic Chinese medical practice. Physicians brave enough to use needling in the operation room were imbued with “the spirit of daring to think and daring to act” (Lee, 1971, 3). Pamphlets featured young revolutionary soldiers needling themselves, encouraging students to engage in self experimentation.

As an extension of political discourse, this kind of gritty epistemology was morally superior to elitist laboratory protocol. And as the politics of the Cultural Revolution turned more radical, campaigns for “mass science” progressively flourished, asserting that expertise was best cultivated by the laboring masses composed of “workers, peasants, and soldiers” (gong nong bin) (Schmalzer, 2008, 162). To revolutionize health care, the ideal doctor would possess all three qualities of the ideal militarized rural laborer. Needling could be applied within and without the
operating room, within and beyond institutional boundaries. Doctors could act as soldiers and soldiers could act as doctors. For instance, one highly popularized case of self-needling featured a People’s Liberation Army soldier who stimulated a “forbidden zone” at the back of his neck to treat deafness and muteness. “The iron tree bursts into flower, mutes regain their speaking power,” began the article, offering a romantic account of medicalized, militarized, and mobilized bodies (Exploring the Secrets of Treating Deaf Mutes, 1972, 1).

But cases of treating deaf-muteness were not isolated to China. In 1970s in New York, acupuncturist Tim Chin also treated deaf patients, which in his experience was not an instantaneous recovery, but a gradual one. “Before a deaf patient comes to me he must have had a hearing test,” Chin explained (Drake, 1972, 18). Then, after meeting once every six weeks, Chin would administer another hearing test. If the patient had not improved, then he refused to continue. If the patient did improve, then he proceeded with the treatment. Unlike the vigorously optimistic tone that described the young soldiers bravely traversing the “forbidden zone” in the back of their neck, Chin exhibited particular caution when describing his own experience with needling to treat deafness.

The effects of needling were both miraculous and mundane. Needling was miraculous, offering a jarring contrast between the many functions of a single needle against the blunt force of a surgical knife. But it was also mundane with the already long history of needling and bloodletting. Locating the needling sites and attaching needles to a battery-powered box was new. Briskly rotating the needle up and down and up to one hundred and twenty cycles per minute was new. But vigorously stimulating needling sites was not new. Historically, needling for bloodletting and cauterizing the surface of the body intentionally induced blisters on the skin, that is, until the introduction of thin painless Japanese needles. And when needles were attached to small white battery-powered boxes, so vigorous were these rotations that they too would leave the site feeling sore with some slight discoloration or bruising (Dimond, 1971, 1563).

Because of the miraculous efficacy of a few needles in the operation room, the patient’s performative agency rendered mundane tasks—such as sitting up and drinking—also miraculous. And it was in the accomplishment of the mundane that drew the attention of skeptics. “Now, in China, to remove a tumour can be as easy as extracting a tooth,” wrote Wong Siu Kuan who had documented Huang Kan-fah’s surgery at the opening of this chapter (Wong, 1972, 43). Wong had once refused help from an acupuncturist in Guangzhou because he doubted the effects of a single needle. But reports of patients sitting and standing on their own after an operation caught his eye.

_I read reports from China describing how patients who had undergone major operations stood up right after their completion, I often wondered how that could have happened. After all, it was common knowledge that most patients had to be taken back to their beds in wheeled stretchers, unconscious, from operating theatres. Anything beyond that would be dismissed as unbelievable._

_Wong (1972, 41–42)_
This kind of individual agency—assisted or not—showed an alternative view of a healthy body. Sitting up and standing up involved one’s full effort. And sitting or standing without falling down demonstrated a kind of control over one’s self. Patients under needling-induced anesthesia did not lose their balance. They remained conscious, and in command.

When cardiologist Edmunds Grey Dimond (1918–2013) first traveled to China in 1971, he too noticed the sprightly movement of patients who sat and stood at the beginning and at the end of their operation. In one case, he watched a forty-year-old man undergo the removal of enlarged thyroid glands. “The patient walked into the operating room, took off his pajama top, retaining the pants, and stretched out on the operating table,” Dimond observed (Dimond, 1971, 1560). The surgical team then administered an opiate called meprobamate to reduce the patient’s anxiety. After a 20-min induction period, the patient started to feel a kind of “numbness and tingling” but could move his hands normally. After another 20 min, the surgeons removed a 3-cm lump from the patient’s throat. Tired, they took a break and the patient drank a glass of water. Then they resumed the procedure. When it ended, the patient sat up, drank a glass of milk, and left the room. During another round, Dimond observed a woman also undergo thyroid surgery. She chatted with the nurses during her operation. A short while later, “[t]he wound was closed and the patient walked away from the surgery” (Dimond, 1971, 1561).

Conversation during surgery facilitated active negotiations between the patient and the practitioner. Like the revolutionary ideology of the Cultural Revolution, it broke an otherwise hierarchical relationship. But unlike the social violence that characterized this period (Esherick et al., 2006), reports from the operation room suggested a calm, controlled, collaborative environment. It was not only that patients were conscious enough to talk to the operating surgeon, but also that they were well enough to drink tea, water, and milk. Again, soldiers could become doctors and doctors could become soldiers. But doctors as patients could also continue to be doctors. For instance, a thirty-two-year-old thoracic surgeon with tuberculosis-induced lung lesion actively inquired about his own procedure before and during his operation. He remained alert as medical staff members injected 10 mg of morphine into the upper part of his cheek, and applied needles his arms. The surgeon then cut into the side of the chest and then removed part of his lung. Throughout the process, the “patient-physician” asked how the procedure was going, and what the surgeons found. His doctor showed him every piece of excised tissue. In the middle of the hour-long operation, the group took a break and fed the “patient-physician” fruit.

In this case, the surgeon’s face was both the site of injection for morphine, and the surface on which the other physicians could actively read his signs of pain. And like the experimental anesthetists in Shanghai, all of the needling sites were on the same side as the lesion, which was still somewhat experimental at the time. The morphine injection site was on his left cheek, the second needling site was located on the left arm, and the incision was applied to the left side of the chest.
We watched his face carefully as the incision was made and when the pleura was incised, but there was no wincing or facial change. His pupils remained equally contracted throughout the procedure. No other form of anesthesia was used except the single, manipulated, forearm needle and the 10 mg of morphine sulfate. 

Dimond (1971, 1562)

Curiously, the materiality of the needle itself did not matter. Historians have recognized that early forms of therapeutic needles made out of bamboo and wood induced similar effects as those made of metal (Lu and Needham, 1980, 70). Chou Kuang-han, who hosted Edmunds Grey Dimond when he observed the procedure at the Peking Medical College, explained that it did not matter if needles were made of steel, gold, and silver. For him, the active input was not electric, but mechano-sensory. Connecting paths between sites were not lymphatic or circulatory, but sensory. For instance, when Chou injected a numbing agent called Procaine into a needling site, the Procaine did not travel and induce numbness at a distance. But when he rotated a needle at the affected site, the Procaine could be activated to block the analgesic effects (Dimond, 1971, 1563). In other words, the materiality of the site—whether flesh, blood, or sinew—responded to the solid features of the needle and not the fluid attributes of the injected chemicals. The needle mattered, not the things that it dispensed. These effects were puzzling. If needling and needling alone induced therapeutic effects at a distance, and if injecting substances at various depths failed to travel, unless they were activated to block the effects of needling, why did physicians bury 10 mg of morphine into a needling site above the cheekbone in the case of the thoracic surgeon? What did this hybridity accomplish? And if Chou suggested that the nakedness of needles—the necessity of needles in the absence of other stimulants—traveled only via paths of mechanical sensation, then how did this correlate with his observation that white blood cells consistently increased in the body after using needles to induce analgesia?

4 Theories of sensation

Nerves remained insufficient in explaining both the full range of pain sensation and the ways in which needling potentially interrupted pain pathways. “At present, acupuncture anesthesia is still in the process of development, and there are still different views on the theory of acupuncture anesthesia,” wrote the editors of the Red Flag Journal. “This is a normal phenomenon,” they added (“Acupuncture Anesthesia,” 1972, 58). Selective numbness through needling was far from a cohesive practice. Even when surgeons found it useful for different conditions and applied it along with other different surgical techniques, the multiplicity of technical possibilities interfered with their ability to explain how it made sense. Instead, uncertainty was just a characteristic of nascent novel practices.

This was in spite of the fact that physicians had been debating how to physiologically interpret and anatomically define medical theory in China since the early
nineteenth century (Lei, 2012). Maintaining health in the body involved the reach of *jingluo*, an extensive network of paths often translated as “meridians.” *Jingluo* connected the surface of the body with internal viscera and could be mediated by movement, choreographed imagination, and ingesting *materia medica* (Lo, 2002). These were the same paths on which needling or burning moxa also acted. By the late nineteenth century, medical writers and practitioners in China grew intensely plural on the ontological nature of meridians. The concept of blood vessels existed in classical texts long before Jesuit missionaries and Japanese physicians translated European anatomical textbooks. In the eighth century, medical commentators had already offered descriptions of arterioles, neuronal branches, and capillary vessels to describe the branching meridian channels (Lu and Needham, 1980, 18). But medical reformers who emphasized the material qualities of *qi* and *xue*—entities that animated paths in the body—asserted that meridians were an independent system separate from neurological and circulatory networks. Others, who placed less emphasis on descriptions of *qi* and *xue*, claimed that meridians were nothing but crude and incorrect representations of blood vessels (Lei, 2016, 75).

These debates carried into the second half of the twentieth century. With the popularization of needling to induce localized numbness, the language of meridians again fit awkwardly among an uncertain terrain of theoretical assumptions. In 1971, historians of medicine Lu Gwei-djen and Joseph Needham visited around twenty different hospitals and research institutions, meeting a number of physicians in Beijing and Shanghai who described the process of needling and heating as “Trial and error probably” (Needham, 1972, 121), “Essentially clinical experience” (Needham, 1972, 141), “Probably mainly empirical, perhaps arose by following sensation after the introduction of needles” (Needham, 1972, 165).

For historians like Lu Gwei-djen, these assumptions were inadequate. Throughout her trips to China with Joseph Needham, numerous physicians attributed the use of few points as evidence of Melzack-Wall’s gate theory, where fewer inputs in the central nervous system would amplify the intended anesthetic effect in the selected area (Needham, 1972, 179). Yet, this still did not address the questions of how needling worked more broadly. For instance, why were analgesic effects more pronounced on the upper regions of the body compared to the lower regions? Why were collections of needling sites more effective on some patients, but not others?

One physician in Beijing suggested to Lu and Needham that the numbing effects potentially operated through three independent networks: the autonomic and sympathetic processes of the central nervous system, the lymphatic system, and the meridians. The physician focused on the central nervous system as the primary explanatory mechanism, but Needham replied that perhaps it was not the only active network. He pointed out that the weaker effects of needling on the abdomen suggested that it did not operate through the autonomic and sympathetic system. “As for the [jingluo] system (whatever it is) the effects go through it,” he suggested (Needham, 1972, 118).
Toward the end of their trip, Needham received needling therapy from two different physicians. At seventy-one years old, his ankles were often swollen, which a colleague suggested could be related to kidney malfunction (Needham, 1972, 213). The first physician, named Li Ta-Li, demonstrated how needling initiated different sensations along particular paths, first stimulating an area on her lower leg and describing a sensation that traveled from the needling site to the surface of her foot. Prolonged sensations of heaviness followed by numbness lasted longer in the arms and legs, and felt more extreme in the torso, she explained. Li then inserted a needle into a site on Needham’s right leg. “Then a downward feeling of numbness (ma) ran along the long bones as far down as the upper surface of foot,” he wrote, adding, “twiddling renewed the sensation each time” (Needham, 1972, 211).

When one physician asked Lu and Needham what they thought about meridians, Needham replied, “[W]e feel undoubtedly it must represent some reality, perhaps more physiological than anatomical, but of course not yet clear exactly what!” (Needham, 1972, 143). The therapeutic and anesthetic effects of needling at particular sites in the body obviously worked, but the relationship among these sites was not always clear. When Li Ta-Li needled at Needham’s leg, Lu Gwei-djen asked her if the path of sensation was in fact a meridian channel. “Yes,” Li replied, “though not always so” (Needham, 1972, 207). The sensation would occasionally travel along different paths, producing different qualities of sensation in different patients and at different points in time. Both historical sources and clinical trials seemed to simultaneously correspond with and contradict one another.

Meanwhile, in the United States, two physicians, Pang L. Man and Calvin H. Chen at the Northville State Hospital in Michigan, had read Edmunds Grey Dimond’s observations of acupuncture anesthesia and tried to develop their own theories of sensation. They experimented and recorded therapeutic effects on themselves and their family members. Man had recently injured his shoulder in a skiing accident and needled the famous hoku site, which was located on the web between his thumb and the index finger. After twirling the needle for half an hour, Man noticed an immediate therapeutic effect. “With this one treatment only, 90 to 95% of the pain had disappeared and he could pitch a baseball again,” he wrote in the third person (Man and Chen, 1972, 392).

Man’s wife also participated in the experiments and volunteered the hoku sites on both of her hands in preparation for a root canal. They had initially tried stimulating the sites to relieve her toothache, but when the dentist decided that the cavities in her upper molars were beyond repair, they went ahead and removed the teeth altogether without any additional anesthetics beyond the stimulated hoku sites. Man wrote,

*The patient was quite elated because she had had previous tooth extractions with the usual side effects of the local anesthesia and post-extraction pain for one or two days. At first the dentist was very skeptical but later commented that he was amazed at the effectiveness of acupuncture “anesthesia.”*

Man and Chen (1972, 392)
Again, needling was rendered both mysterious and mundane. The hoku site was easy enough to access on the hand. Following Man’s previous success with treating his shoulder injury, he used the same site to relieve pain in his wife’s upper jaw. These two cases involved different sources of chronic and acute pain. Stimulating the hoku site had removed the discomfort of damage from a fall, and also relieved the pain of tissue damage from a deteriorating cavity. For Man’s wife, this kind of numbness also transferred to the drills used to dislodge and extract her teeth. And following the operation, she felt no lingering discomfort.

A few months later, Man volunteered to use needling in preparation for surgery on his left knee. Guided by the descriptions in Dimond’s series of case studies, Man prepared an intravenous drip with 60mg of opioids before applying a needle below the kneecap in each leg and attaching it to a battery-powered generator. He waited 20 min before starting the procedure, which also lasted for around 20 min. They had used less than a quarter of the intravenous solution and just a fraction of the opioid mix, which was significantly less than the full “dose” of needling under each knee (Man and Chen, 1972, 392).

Rather than following Melzak and Wall’s theory of a single gate that controlled pain, Man and Chen instead suggested two gates. The first gate would still be found in the spinal cord among a low concentration of myelinated neurons. This area in the spinal cord would receive signals from two types of fast-firing neurons as well as low-conduction slow-firing neurons. In their estimation, as long as needles at the periphery of the body interacted with fast-firing neurons, they would be able to reach this gate and interrupt the signal. The second gate would be found in the brain, in particular the thalamus, which he suggested would block all of the pain that was not captured by the first gate. This system of filters selectively extrapolated discrete forms of pain.

Yet, these theories of pain did not explain the wide therapeutic range of effects that needling induced. Man and Chen both recognized that needling could be used to treat paralysis, muteness, infections, and hypertension. Empirically satisfied with their own experiences, they remained dissatisfied with the still limited perspective that their experience offered. “Therefore, we believe that even though acupuncture appears to have some merits, many important aspects are still unknown and require extensive scientific investigations,” they concluded (Man and Chen, 1972, 393). Needling worked, but its techniques and outcomes varied; its physiological responses reinforced emerging theories of pain, while simultaneously extending beyond the simple explanatory framework of the central nervous system.

In London, Felix Mann (1931–2014) also conducted his own experiments on needling and numbness. Inspired by reports like those of Han Suyin that described using an electric probe to locate meridian paths and needling sites, Mann became one of the few physicians in Britain to learn needling techniques with a medical degree. As he read about how sites with lower electrical resistance were potentially more sensitive to needling, Mann acquired an electric probe to locate needling sites on his own body. But to his disappointment, he found none. “I found that however diligently I tried using this apparatus, I could detect neither acupuncture points, whether active or inactive, nor meridians,” he lamented (Mann, 1983, 80). This mounting
disappointment left Mann feeling that the classical texts he had closely studied and meticulously translated into English were misleading. He blamed his naïveté, which was “[f]illed with the enthusiasm of youth” that rendered him uncritical and vulnerable to deception (Mann, 1983, 80).

Despite Mann’s rejection of classical texts, he still followed classical instructions. He used palpation for diagnosis, paid attention to the six types of pulses on each wrist that linked to over a thousand sites in the body. He treated patients with compounded forms of pain, such as a woman with a herniated disc. He noticed that she was a “sensible, unemotional woman,” and had over twenty years of pain following a car accident that was exacerbated after surgery removing the scar tissue left an intense pain in her left posterior (Mann et al., 1973, 58). He applied needling on the right foot, which had no effect. Then he moved to the left foot, then added a sit close to her shin, and then added a fourth needle on her right wrist. Unlike the analgesic surgeries that had been widely reported from hospitals in Guangzhou, Shanghai, and Beijing, Mann did not rely on reducing select sites to a single needle, but instead applied more needles until he found the right combination (Mann et al., 1973, 59).

Curiously, the metaphor of gate control did not take into account the different causes of pain, the causes of relief, and the different temporalities on which these causes operated. In the surgical context, relief and numbness via needling required a 20 min induction period. And in the cases of surgeries, from tooth extraction to thyroid surgery, the effects of the needling lingered long after the surgery had passed and long after the needles were removed. Without a constant source of input into the gates, the needles either had changed the constitution of the body, or the “gates” only served as partial physiological metaphors at best.

5 Materiality of the mind

When Felix Mann compared individuals who experienced discomfort from sciatica, phantom limb, fractured teeth, impact injuries, among others, he recognized these as different categories of pain with different temporalities and different temporal responses to needling. Some of the pain was relieved in three days, some after 30 min, some after two weeks. For patients who experienced relief, needling to remove unwanted sensation “worked,” but because Mann could not predict the temporality of recovery—or how long it would take for each patient to respond—he refused to generalize across cases.

Rather than further engaging with the materiality of gate-control theory, Mann and other physicians turned to the materiality of the mind. The effects of numbness and needling converged in the body, but theorists increasingly suggested that these effects were produced from within, not without. It was manifested through suggestion, much like hypnosis. Others, too, attributed therapeutic effects as a kind of placebo. At one medical conference in Seattle, members suggested that needling operated “much the same as that reacting favourably to placebo administration,” wrote Mann et al. (1973, 60).
Placebo increasingly came to serve as a shorthand for the pluralistic effects of needling. Even if patients described discrete effects in their own bodies, physicians found it difficult to identify discretely elements of cause and effect. If signals were passing through the spinal cord and into the brain, perhaps they operated on specialized cells. As Mann pronounced,

*Activity in these brainstem regions can alter the perceptual quality of impulse patterns passing through the reticular formation, producing analgesia. Cells of origin of the spinocervical tract in cats can be inhibited by strong stimuli in regions far from (and even contralateral to) their excitatory receptive fields.*

Mann et al. (1973, 60)

According to this explanation, spinal inputs converged in the brain and passed through other areas that could also induce numbness. But these mechanical circuits were at odds with comparing the effects of needling to hypnosis and placebo, where the mechanical inputs remained unclear because the boundaries of material substances in the body and the brain remained unclear.

To dispel the association between needling and suggestion, Chou Kuang-han at the Peking Medical College shared with Edmunds Dimond his study on the effects of needling on dogs. He produced a lesion in two dogs, one which received needling and another that did not. The dog that received needling smoothly recovered from the lesion. The untreated dog died in shock. Still, this did not mean that needling did not induce effects in the brain. In his conversation with Dimond, Chou explained that his groups had found that appropriately placed needling sites could produce sleep and a sleep-pattern electroencephalogram in cats, dogs and rats (Dimond, 1971, 1563).

Writers in Singapore also took on the question of hypnosis, treating it as a state of mind that was as mundane as daydreaming. “Hypnosis may seem mysterious, but everyone has been spontaneously in self-hypnosis under certain conditions,” wrote T. M. Chong, “This probably happens to all of us every day” (Chong, 1972, 4). Chong understood that hypnosis as a technique of practice had emerged in parts of Europe and North American, not in East Asia. To better understand the effects of hypnosis, Chong wrote to the American psychiatrist Milton H. Erickson (1901–1980) on his thoughts about needling. Erickson explained that because his only encounter with needling was a failed encounter, he instead assumed that his physician deployed the techniques of hypnosis. In his reply, Erickson wrote,

*I did become convinced that the acupuncturist was employing an excellent hypnotic technique, and I duplicated it on several patients without divulging my intentions to induce a state of hypnosis. One of my patients was totally unacquainted with me or my reputation, but nevertheless developed a trance state by describing the hypnotic experience as a comfortable, pain-relieving state of relaxation and comfort during which one “drifted off” and “forgot” to pay attention to the surrounding environment.*

Chong (1972, 4)
For Erickson, the material input for his patients who either “drifted off” or “forgot” about their pain was based on both circumstance and technique. When writing to Chong, Erickson simply defined hypnosis as an active process of communication of ideas between the practitioner and the patient who would be primed to control his or her own thoughts and behaviors. This kind of communication evaded the metaphor of gate control, and instead described the ability for the patient to simply exhibit control. While historians have written in close detail the cultural history of mesmerism (Ogden, 2018), the mechanism of hypnosis remained unclear, and the politics of elucidating how hypnosis “worked” further differed from the politics and material culture of needling.

When asked if the effects of needling were the product of suggestion or hypnosis, Chen Tseg-ming at the Guangdong Provincial People’s Hospital replied, “obviously not” (Dimond, 1971, 1562). For Chen, it was unlikely that the thousands of patients that positively responded to needling could have all been hypnotized. In particular, his staff routinely used needling in the emergency room on a number of patients who came in with severe fractures. Needling would reduce their physical trauma so that they would not encounter more complications if they were in shock. “[T]here was no opportunity for autosuggestion,” Chen explained (Dimond, 1971, 1562). Cases of emergency involved an element of improvisation, which could only be realized with the immediate effects of needling. Unlike Erickson’s description of a focused communication between practitioner and patient, the un-staged setting of the emergency room stood in contrast to the quiet and self-conscious arena of the operation room.

Similarly, Tim Chin who operated out of his clinic in downtown New York and treated deaf patients, explained to a reporter, “Some doctors have suggested that acupuncture is just a mental treatment, that I tell the patient what will be happening. So I am careful not to suggest anything” (Drake, 1972, 18). As fourth-generation acupuncturist, Chin had trained in Shanghai where he learned the classical theories of the five phases as diagnostic and heuristic categories. And from his clinic, he treated stroke patients who suffered partial paralysis, observing one patient who immediately regained his motor function after one treatment. The patient could not raise his arm or bend his elbow for nine months, which exasperated his doctors. Chin reflected on the encounter with ease. “It’s like a miracle, but it isn’t a miracle,” Chin thought (Drake, 1972, 14). A number of patients often recovered within one treatment. Puzzled, they would return to Chin for a second treatment even when they felt no pain.

Chin observed that not only did his treatment eliminate acute paralysis and chronic pain, but it also helped patients to ease off of their medication. “Many patients who come to me take a lot of pills,” Chin explained, “But they learn that they can go longer between the times they take their pills” (Drake, 1972, 19). Chin not only reduced the frequency of their medication, but also the volume. Some patients would arrive at the clinic waiting 2h between each dose. Chin then extended their wait time between doses from 3 to 4 and 5h. Other patients reduced their intake fourfold. Throughout these cases, needling introduced an element of surprise. Beyond the operating room, different theories of how needling acted on the body cast...
a wide net from metaphors of gates that opened and closed to the generalized effects of suggestion. And when taking into account the idiosyncratic ways of being and the range of conditions in which needling intervened, the introduction of new explanations could not generalize across the general effects of a deceptively simple therapeutic technique.

6 Conclusion

As a heterogeneous category of treatment, “acupuncture anesthesia” both took on multiple temporalities of sensation and multiple categories of numbness. Needling not only reduced sensations of pain, but also reduced dependency on medication. In the surgical arena, needling-induced analgesia blocked sensitivity to a complex combination of sensory input from multiple surgical instruments. The effects of needling further extended to postoperative care. Beyond the surgical ward, a single treatment could relieve long-term chronic pain induced from a variety of injuries from herniated discs to rotting cavities.

The language of “anesthesia” as a category of numbness—especially when physiologists and psychologists turned to the role of the patient’s own mind—not only involved the selective elimination of pain, but also the selective elimination of desire and dependency. Soon after the watershed of clinical and experimental reports of “acupuncture anesthesia” that featured photographs of patients awake, alert, and participating in surgery, groups of researchers began surveying and theorizing about the role of needling in addiction. In the late 1970s, one group suggested that needling potentially induced analgesia by stimulating the release of opiates in the pituitary glands (Pomeranz, 1977). Another group studied the detoxification effects of needling with low levels of opioids among drug addicts (Wen et al., 1977). These were among hundreds of experimental studies performed in China, Hong Kong, Singapore, Macau, Britain, Germany, and the United States that collectively drew on and complicated discourses of “acupuncture anesthesia” that visually cohered in photographic essays that centered on the patient’s face.

The many displays of “acupuncture anesthesia” were both miraculous and mundane. Photographs of patients smiling into the camera, drinking tea, or eating fruit with the insides of their stomach, chest, or skull exposed visually gestured to the expansive therapeutic effects of needling. To some critics, acupuncture analgesia worked, but it only worked on Communist Chinese bodies. To others, it confirmed Ronald Melzack and Patrick Wall’s theory of “gate control.” To others still, acupuncture analgesia exposed the universal effects of needling and the limitations of gate-control theory. The conscious patient actively involved in the clinical encounter conflicted with those who suggested that patients were only hypnotized, distracted, and deceived. These explanations did not diminish the embodied experience of needling, but they did bring together seemingly conflicting notions of sensation that complicated how pathways at the periphery of the body intervened, intercepted, and evaded actions in the brain.
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Further reading

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Tang, S., 2006. “From outcast to inboard”: the transmission, professionalisation and integra-
This volume explores the long history of brain research through a series of eleven self-contained and yet interconnected episodes. Through a sweeping narrative that spans from conceptions of the brain in late antiquity to the present, the volume challenges a narrow definition of “progress” in brain research in any linear sense. It shows that the history of brain research is best reimagined historiographically and conceptually as a patchwork of interconnected perspectives, rather than a unified, monochrome fabric of secure knowledge. The stories presented are episodic glimpses into the practices of refashioning and reimagining a field and its main object, the brain, whose histories speak of change as the main – and perhaps the sole – unifying thread.

Cover image: ‘The anatomy of the brain’, 1802, by Sir Charles Bell. Credit: Wellcome Collection. CC BY