A Medical Investigation

Rocky Mountain Spotted Fever. History of a Twentieth-Century Disease. VICTORIA A. HARDEN. Johns Hopkins University Press, Baltimore, MD, 1990. xvi, 375 pp., illus. $39.50. Henry E. Sigerist Series in the History of Medicine.

When I was growing up in North Carolina in the years after World War II, the culmination of a spring or summer day spent exploring the woods and fields of the surrounding countryside included a hot bath and a search for ticks. Our mother told my brother and me that tick bites would make us sick and that people could die from what she called Rocky Mountain spotted fever. As it turns out she had reason to be concerned. Despite its association with the western states, Rocky Mountain spotted fever is found throughout the Western Hemisphere, and in 1981 North Carolina had the largest number of reported cases in the United States.

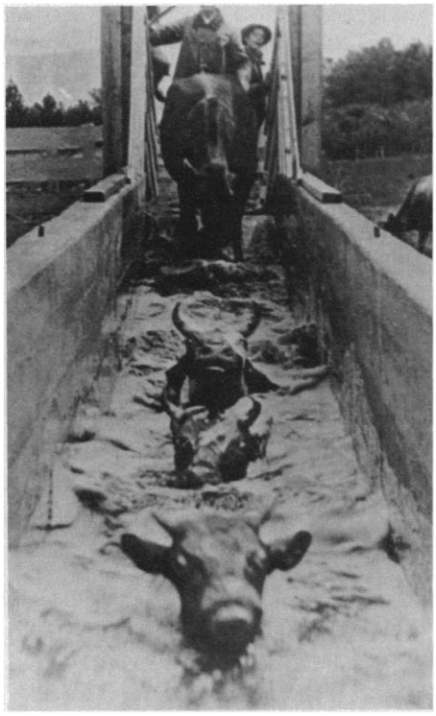
Victoria A. Harden's *Rocky Mountain Spotted Fever: History of a Twentieth-Century Disease* offers important insights into the impact of public policy on medical research and public health. Harden draws on archival records, oral history interviews, and scientific publications in constructing her narrative. The prose is lively, and although there are places where the scientific detail might be too much for some readers, Harden's book should be enjoyable and informative for the specialist and generalist alike.

Harden wishes her study to be read as a "romance" about the efforts to diagnose, prevent, and treat spotted fever, and her affection for the determined researchers is evident throughout. But the book has more the feel of a good detective novel. The crime public health officials and medical investigators confronted involved the death of dozens of people in the Bitterroot Valley, located in western Montana along the Idaho border. The threat of additional loss of life and harm to the economic development of the area called for immediate action. The first gumshoes on the case were two pathologists. As sometimes happens in scientific investigations, they quickly came up with a logical theory for the disease in keeping with the latest thinking of the day. Spotted fever, they concluded, was a piroplasma carried by ground squirrels that infected ticks that then transmitted the disease by biting humans. Unfortunately, closer scrutiny failed to find the parasite in the blood of the victims.

Howard Taylor Ricketts headed the second wave of investigation, and he proved to be a more ingenious sleuth. Combining a solid background in both the latest European laboratory techniques and theoretical microbiology with an unusual ability to design successful experiments, Ricketts changed the direction of the scientific study of spotted fever. He confirmed the wood tick as the carrier of the disease and proved that infected ticks, although few in number, did occur naturally. Ricketts then divided his time between a search for the organism that caused the disease and efforts to develop a vaccine and antiserum against it. He eventually isolated a bacterial organism as the culprit in the case of the Rocky Mountain spotted fever and had the dubious distinction of having it named in his honor. *Rickettsia rickettsii* represents a subgroup of rickettsial diseases that includes epidemic typhus.

Unlike the characters in a Raymond Chandler novel, scientific investigators faced real dangers. While studying typhus in Mexico City, Ricketts became infected with that disease and died within a short time. It was left to others to look for ways of preventing and treating spotted fever, and others also lost their lives.

Researchers and public health officials sought to control the host tick even as they searched for a successful vaccine. They dipped livestock, cleared fields, and killed infected animals, all of which helped reduce



"An arsenical solution killed ticks on the hides of livestock in the fifteen seconds it took to swim through the concrete dipping vat. Rocky Mountain wood ticks, however, preferred to attach themselves around the horns and ears of cattle. It was nearly impossible to submerge the heads of the cattle for longer than one second, which was insufficient time to do serious harm to engorged female ticks." [From *Rocky Mountain Spotted Fever*; National Archives and Records Administration]

"Built by the state of Montana in 1928 for spotted fever vaccine production, this laboratory was located in Hamilton, Montana, on the uninfected east side of the Bitterroot River. To prevent infected ticks from escaping, it incorporated many special features, such as rounded seams where walls met floors and a moat around its perimeter, across which ticks reportedly could not swim." [From *Rocky Mountain Spotted Fever*; Rocky Mountain Laboratories, NIAID]

the number of ticks. Roscoe R. Spencer and Ralph R. Parker eventually developed a vaccine produced from ground-up ticks, according to Harden "the first human vaccine prepared from the bodies of arthropod vectors." Improved vaccines dramatically reduced the danger of spotted fever, and with the introduction of broad-spectrum antibiotics a cure had been found. Antibiotics and insecticides used to reduce the tick population, although not eliminating the disease, brought it safely under control.

Complacency among the scientific community and the public alike caused a reduction in research in spotted fever after World War II. But as suburbanization stimulated development in tick-infected areas, the number of cases began to rise. By the 1970s researchers were again at work looking for more sophisticated ways to combat the disease. "The history of Rocky Mountain spotted fever," Harden concludes, "stands not only as a tribute to organized inquiry in the medical sciences but also as a reminder that, because humans and microorganisms share the earth's biosystem, vigilance against infectious diseases must continually be maintained." Her excellent study greatly increases our knowledge and understanding of these important issues.

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The Auditory Scene

Auditory Scene Analysis. The Perceptual Organization of Sound. ALBERT S. BREGMAN. MIT Press, Cambridge, MA, 1990. xvi, 773 pp., illus. $55. A Bradford Book.

How do we recognize and understand spoken words when we are talking to someone in a noisy room? A spectrogram of a word uttered in a quiet place is distinctive. Mixing a spoken word from one speaker with the babble from many others buries the frequency characteristics of the word so as to disguise it completely in the spectrogram, yet a speaker may still be easily understood. The phenomenon is not unique to speech. The voice of a trumpet is readily followed in the rich sound of the orchestra as a whole, and it is easy to shift attention from the sound of trumpets to the sound of violins. The ear is bombarded with a complex spectral tangle, yet we are able to follow the spectral signature unique to a given instrument.

To this formidable problem—the problem of analyzing the highly complex acoustic scene surrounding us into its meaningful perceptual constituents—Bregman has brought fresh wisdom. His book is a distinguished realization of an empirical and theoretical development in the world of psychoacoustics that began some 20 years ago. Earlier, psychoacousticians were addressing their efforts primarily to the classical psychophysics of simple auditory stimuli. The need to understand the acoustics and the principles underlying speech perception, however, stimulated a trend to study more complex acoustic signals. Recently, that has included the continuing study not only of speech perception but also of the more complex signals associated with, for example, profile analysis (here, *profile* refers to the pattern of intensity of partials in the spectrum) and the pitch, timbral, and rhythmic components and structures characteristic of Western music (see, for example, D. M. Green, *Profile Analysis*, Oxford University Press, 1988; S. Handel, *Listening*, MIT Press, 1989; and C. L. Krumhansl, *Cognitive Foundations of Musical Pitch*, Oxford University Press, 1990).

What is auditory scene analysis? In Bregman's words, it is "to take the sensory input and to derive a useful representation of reality from it." One of the primary functions of this analysis is "to decide which parts of the sensory stimulation are telling us about the same environmental object or event." The hearer accomplishes scene analysis, he argues, through an interaction between the organizational principles identified by Gestalt psychology and the phenomena associated with auditory stream segregation and integration.

With auditory stream segregation, things that sound alike (for example, that have the same overall pitch or timbre) as they move in time tend to be organized into distinct and separate acoustic objects or events. This organization depends on other things, of course, such as the rate at which auditory events occur. For example, if the notes of two familiar melodies are alternated in sequence in the same pitch region, we hear a mishmash and are unable to distinguish the melodies. But if we gradually move the two melodies apart so that one becomes progressively higher in overall pitch while the other becomes lower, they begin to emerge as two distinguishable streams. This is so even though the acoustic stimulus still consists of a sequence of pitches alternating note by note from one melody to the other. Grouping principles have coalesced the ongoing auditory information into high and low streams—into distinct auditory events that go together in time.

If stream segregation describes the conditions in which ongoing auditory events will stream together in time, then how does the auditory system assure that events occurring simultaneously in that stream will be perceived as distinct events? And what facets of our perceptual experience depend on this grouping? One principle is that of the "old-plus-new" heuristic. Our auditory systems use this rule as follows: if in a stream of simultaneous auditory events one event can be reasonably grouped with its predecessor, then do so, remove it from the mixture, and go on to similarly analyze the remaining events in the simultaneity. This thinking obviously leads to a stress on spectral organization and analysis—it asks not only when spectral components of complex sounds will fuse, but also when they will segregate into perceptually independent events. Another principle is that of "exclusive allocation." Here the claim, backed by much evidence, is that the auditory system tends to place acoustic events into one stream or another, but not at the same time into two or more.

Are the processes of auditory scene analysis all innate and governed solely by the unlearned primitives of Gestalt psychology? Not at all. There is much evidence, especially from studies of speech perception, that the auditory system supplies information based on experience to interpret and "fill in" the ongoing acoustic stream. Auditory interpretations based on familiarity lead to the idea of "schema-based organization." In other words, auditory scene analysis depends on two overarching principles: primitive analysis, which is unlearned and effortless, and schema-based organization, which is learned and summons active attention to auditory information.

In two shorter chapters, Bregman applies his ideas specifically to the worlds of music and speech. His approach offers a wonderful way of thinking about these domains. In the chapter on music, for example, he shows how composers have implicitly incorporated principles of auditory scene analysis in their music. In his book in general, and in this chapter in particular, Bregman sketches the principles necessary for a formalization of many intuitive principles that have been used skillfully by auditory artists for years. In that sense, the book joins others written recently, such as Lerdahl and Jackendoff's *A Generative Theory of Tonal Music* (Harvard University Press, 1983) and Krumhansl's *Cognitive Foundations of Musical Pitch*, which have sought to provide formal explanations for the perception of music.

Outside of the world of research on audition and hearing, who will find this book of interest? Bregman presents his ideas as a challenge for those interested, for example, in artificial intelligence and the general formalizations it can provide. Similarly, the theory and data under discussion will provide major guideposts to the functional neurology of complex acoustic perception.