

## Ludwik Fleck and the Art-of-Fact

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Truth may be beauty, but more in the eye of the beholder than we generally acknowledge. Does it matter?

In science we routinely assume that whatever theory we may have about them, facts themselves are things that *are*—out there in the world to be observed. However, it has become rather standard for historians and philosophers to assert instead that “facts” are human constructs understandable only in a particular historical or societal context. They note that scientists typically argue over very different theories to interpret the *same* data. We in turn resist this deconstruction by outsiders who themselves don’t have to face the struggles of understanding Nature. Nonetheless, there may have been more than idle poetry in Keats’ assertion that “truth is beauty and that is all ye need to know.” Facts may be more determined by the theoretical lenses through which we view the world than we like to think.

### TRUTH AND PROGRESS IN SCIENCE: “THE BONDS OF HISTORY CAN NEVER BE CUT”

Thomas Kuhn’s famous book *The Structure of Scientific Revolutions*<sup>1</sup> had a transforming effect across both the academic and popular culture landscapes. It gave us the satisfying term “paradigm shift” for the episodic

bursts of change by which we so often, perhaps so vainly, characterize our own research or field. Kuhn argued that a scientific revolution occurs when a new explanation for the available data becomes accepted by the body of scientists, a sociocultural phenomenon very different from the prevailing notion of science as a fact-driven process. The notion has been applied, but not without discussion, to all fields of endeavor including anthropology.<sup>2,3</sup>

A new theory may be more accurate in some ways, or account for more facts, but Kuhn’s notion of a paradigm shift was not about contests between different ways to apply an existing theory, like that of evolution, to the available facts, such as fights between cladists and phenetic systematists, or out-of-Africa versus regional continuity models of evolution. Rather, a paradigm shift is a *gestalt* change in which a new interpretation of the body of existing facts replaces, and is *incommensurable* with, an existing theory. Evolution contrasts with creationism in this respect, for example.

Most scientists strongly assert—*believe*—that such changes constitute *progress* in the sense of major steps closer to understanding the truth that we assume is out there to be found. However, it is perhaps not sufficiently appreciated that scientific theories are almost always inconsistent even with some of the established facts of their time, and this was true of the victors in classical Kuhnian “revolutions,” including even the archetypal Copernican one. Whether this is progress toward truth is harder to answer than we may think. Kuhn drew an analogy

with biological evolution: science works by contingently sorting through *available* facts or ideas in the context of their own time, but cannot really be teleologically heading for truth, because we have no way to know where to find it.

Kuhn was influenced by a little-known 1935 book he had stumbled across, *Genesis and Development of a Scientific Fact*, by a Polish physician named Ludwik Fleck.<sup>4</sup> Fleck had anticipated (or shaped) many of Kuhn’s ideas. Though rather obscure today, Fleck has been called the founder of the philosophy of modern medicine. His concern was not so much with revolutions but with the way that even the supposed facts of science are driven by context. He stresses that “concepts are not spontaneously created but are determined by their ‘ancestors.’” Fleck’s term comparable to Kuhn’s “paradigm” was *thought collective* (we might say “school of thought”) and his objective was to understand how an unorchestrated community of scientists establishes what are considered facts around a theory that necessarily grows out of historical roots. What counts as fact varies with time and context. Fleck likens science to troops on the march, a small vanguard followed by a main body. New observations provide some corrective, but *which* of the vanguards the main troops follow is unpredictable, and affected—or determined—by sociopolitical and cultural factors.

This challenges our cherished mythology that we are doing “original” research. Most of us are not as original nor independent as we may fancy. Without a herdlike ideological coherence, science as the public enterprise we know today might not be possible, since any individual can only see or do so much. But the herd itself defines what progress is, and the more who

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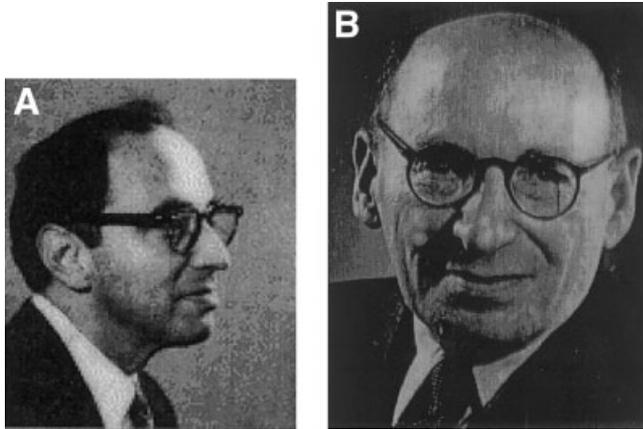


Figure 1. A. Thomas Kuhn ([http://www.malaspina.com/site/person\\_733.asp](http://www.malaspina.com/site/person_733.asp)); B. Ludwik Fleck (reprinted with permission, from Polish Philosophy web site: <http://www.fmagn.unict.it/PolPhil/Fleck/Fleck.html>).

participate the stronger and more resistant to displacement (creative or free thinking) it becomes, and the prevailing thought collective becomes a thought *constraint*. “Whole eras” can be ruled by a thought constraint. Heretics are not well tolerated; we don’t burn them at the stake but the Lysenko era showed that we may send them to freeze to death in labor camps, and today we freeze them out of research funds. As with any ideology, defendants of the thought collective argue that they defend it because it’s *true*.

Ludwik Fleck worked in the pre-World War II era in his native Poland. Poland was intimately involved in conflicts in that region, including the Communist revolution in neighboring Russia. Social, historical, evolutionary, and contextual analysis of human affairs was part of the intellectual life of that era in Europe. Fleck’s choice of the term “thought collective” seems to reflect that context, and he states a rather classically Hegelian or Marxist assessment of conflict in science, as being between opposed theoretical views that resolve into a new consensus. Fleck says that “after the change in thought style, the earlier problem is no longer completely comprehensible.” This contrasts a bit with Kuhn’s idea, because a *problem* is not identical to an explanatory framework. But to Fleck the two are inextricably related.

### ON BECOMING FACT: THE WASSERMANN TEST FOR SYPHILIS

The predominant medical problem of the time was infectious disease, and Fleck exemplified his ideas by showing how concepts of syphilis, growing from earlier notions of causation, led to the development of the Wassermann test to detect the disease. Syphilis had long been viewed primarily in moral dimensions, a “carnal scourge.” In part a legacy of the age-old humeral theory, diseases of generalized or vague symptomatology were assumed to be due to fouling of the blood. This notion grew to the point that the early 20<sup>th</sup> Century demanded a “blood test” to detect the disease. Infectious microorganisms were known by then, and Pasteur had recently organized (and orchestrated) the scientific and bureaucratic machinery in France around the concept of infectious disease causation.<sup>5</sup> European nations scrambled not to be left scientifically behind in this endeavor. However, symptoms, specificity, and sensitivity of known reactions and available tests made both the disease and its diagnosis problematic. Symptoms of syphilis were not coincident with the visual (microscopically detectable) presence of the spirochete bacterium *Treponema pallidum*, though people were convinced that that was the cause. The disease took different, often indefinitely delayed, courses in different individu-

als, and other diseases such as leprosy also generated a positive test reactions as well as similar symptoms.

Under these conditions, whether it was a “fact” that someone had syphilis or not was not purely objective but depended on the assumptions about its particular cause. Many investigators—the “thought collective”—worked, if only in a loosely coordinated way, to find a syphilis blood test. In 1906, August von Wassermann and colleagues developed the famous reaction that bore his name. On the assumption that the test directly detected bacterial antigens, a positive Wassermann reaction was used to *define* syphilis, separating it by this single criterion from other diseases with similar symptoms.

Despite these elements of what seemed like “truth,” the inferences from experiments leading to the Wassermann test were incorrect or purely empirical in essential ways. The theoretical understanding of the reaction was in fact wrong. A positive reaction was interpreted as proving spirochete causation because the theory was that antigen-antibody reactions were specific. The method to detect the presence of antigen produced by the spirochete is known as *complement fixation* (Figure 2). In the first step, syphilitic tissue used as a source of antigen was mixed with blood from the person being tested. In an infected person, the antigen binds to antibody, and complement (a component of the immune system) is fixed to the antigen-antibody complex. A properly prepared reagent, like red blood cells (rbc’s), is then added. This causes no reaction in samples from infected persons that at this state no longer contain free complement, but the unbound complement in the blood of an uninfected person binds to the rbc’s, producing an easily detected hemolytic reaction.

Much of Fleck’s book is an account of the many ways this process was a prisoner of its history and the thought-collective’s erroneous choice of assumptions: “It is only after the choice has been made that the associations produced by it are seen as necessary.” I can’t give the details here, but over time, a legion of investigators had to tinker with many of the conditions to make the test even reasonably

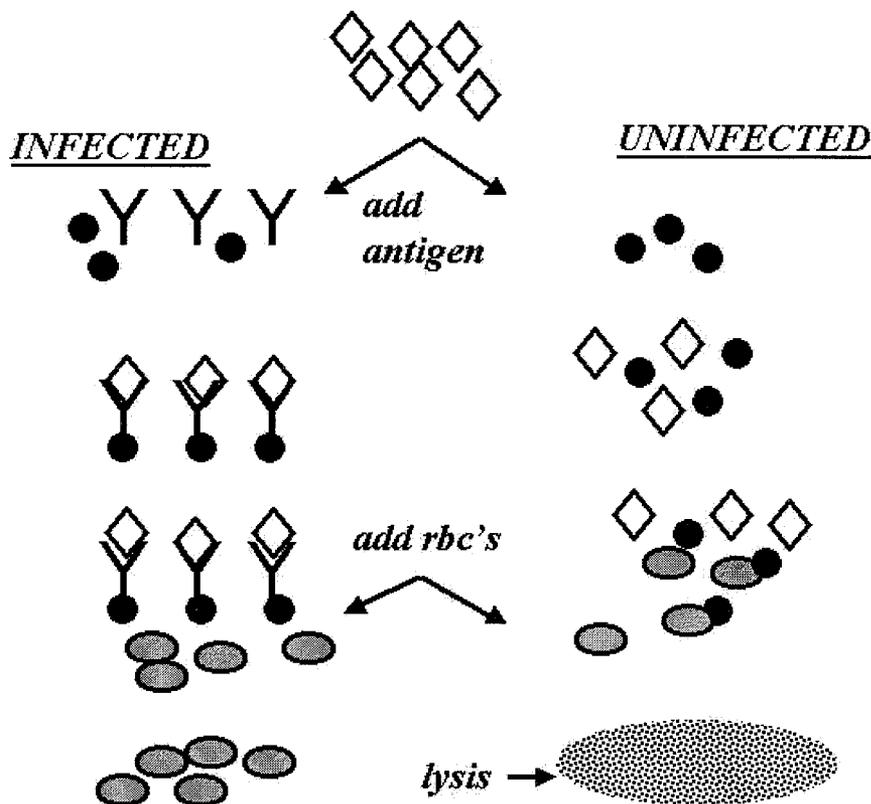


Figure 2. Complement fixation test. Left, positive test; right, negative test. Moving top down, antigen (diamonds) introduced to blood sample binds to antibody (Y) which captures complement (dark ovals) in infected (left). Complement remains free in uninfecteds (right). When red cells (rbc's, grey ovals) are added, they are bound by the free complement in uninfecteds, and lysed. In uninfected, no complement is free to lyse the rbc's. Schematic.

reliable—at least for clear-cut or late-stage cases. They had to filter the “facts” empirically and selectively through their presumptive lens because, among other things, it was later found that *uninfected* tissue used as a source of antigen could also generate a positive reaction. We now know that a constituent of healthy tissue, *cardiolipin*, mimics the antigenic properties of *T. pallidum*. Other conditions also induce antibodies to cardiolipin, including the other treponemal organisms, and why *T. pallidum* does so is still unclear. Nonetheless, the drive for a blood test paid off. The reasoning by which a positive reaction was related to syphilis was wrong. But the test became *fact*.

We can consider this in light of late 19<sup>th</sup> Century science, with its belief in atomic units of ultimate, universal causation. Biomedical science found its causal units in infectious organisms. The contemporary view was re-

flected in G.B. Shaw's introduction to his 1911 play *The Doctor's Dilemma*:<sup>6</sup> “The whole art of healing could be summed up in the formula: Find the microbe and kill it. . . . When there was no bacillus it was assumed that, since no disease could exist without a bacillus, it was simply eluding observation.” These views were so entrenched that Shaw mused that it was not clear whether vaccination programs are forced by doctors onto the public or vice versa.

The causal metaphor of the time was one of combat between an individual against an invasion of microorganisms. However, many microorganisms live commensally with us, and the highly variable relationship between the spirochete and symptoms shows that the metaphor was imperfect. The parasite and antibodies are found in the blood, but syphilis is not really a disease “of” the blood the way anemia or leukemia are. The patho-

gen can be present without the symptoms, or vice versa, so that defining syphilis as “the disease caused by [*Treponema*] *pallida*” reflects a thought-collective's preconceptions about causation as much as it does the reality. History constrains thought so that at any time most of us can't think in any other way. Since Fleck's time we have developed more precise ways including direct detection of treponemal gene sequences to detect the presence of what we have defined as the cause. But the etiological concept is not the only possible, and may not be the best, definition of diseases. They could alternatively be classified by the treatment they respond to, virulence, the organs they affect, or their symptoms, and there are often multiple causal factors. But that is not how we think in science in our present era.

#### A MODERN RERUN?

There are striking parallels in today's AIDS epidemic. AIDS, like syphilis, is viewed as a disease of the blood (because of immune deficiency), and has even been seen as another “carnal scourge” of moral dimensions. One can have symptoms of AIDS without HIV and vice versa. The standard HIV test is an indirect one for antibody to the pathogen, and does not detect perfectly nor immediately after infection. Many host factors like nutrition and the burden of other disease affect the course of the disease, which can be indefinitely delayed. As with syphilis, the symptoms are not unique to HIV as the “cause”; there are many ways to get pneumonia, but pneumonia in someone HIV-positive is *defined* as AIDS. There is even a cottage industry that claims the huge momentum of the AIDS “thought collective” has been misdirected by an unjustified proclamation in the 1980s that HIV is a proper etiological entity. Are they flat-earthers or could the thought collective actually be wrong? Or if truth is not clearly an attainable goal, is “wrong” even the wrong concept?

#### PARADIGM OR PROPAGANDA?

Fleck describes how a thought collective maintains itself by various ways of inculcation. Academic de-

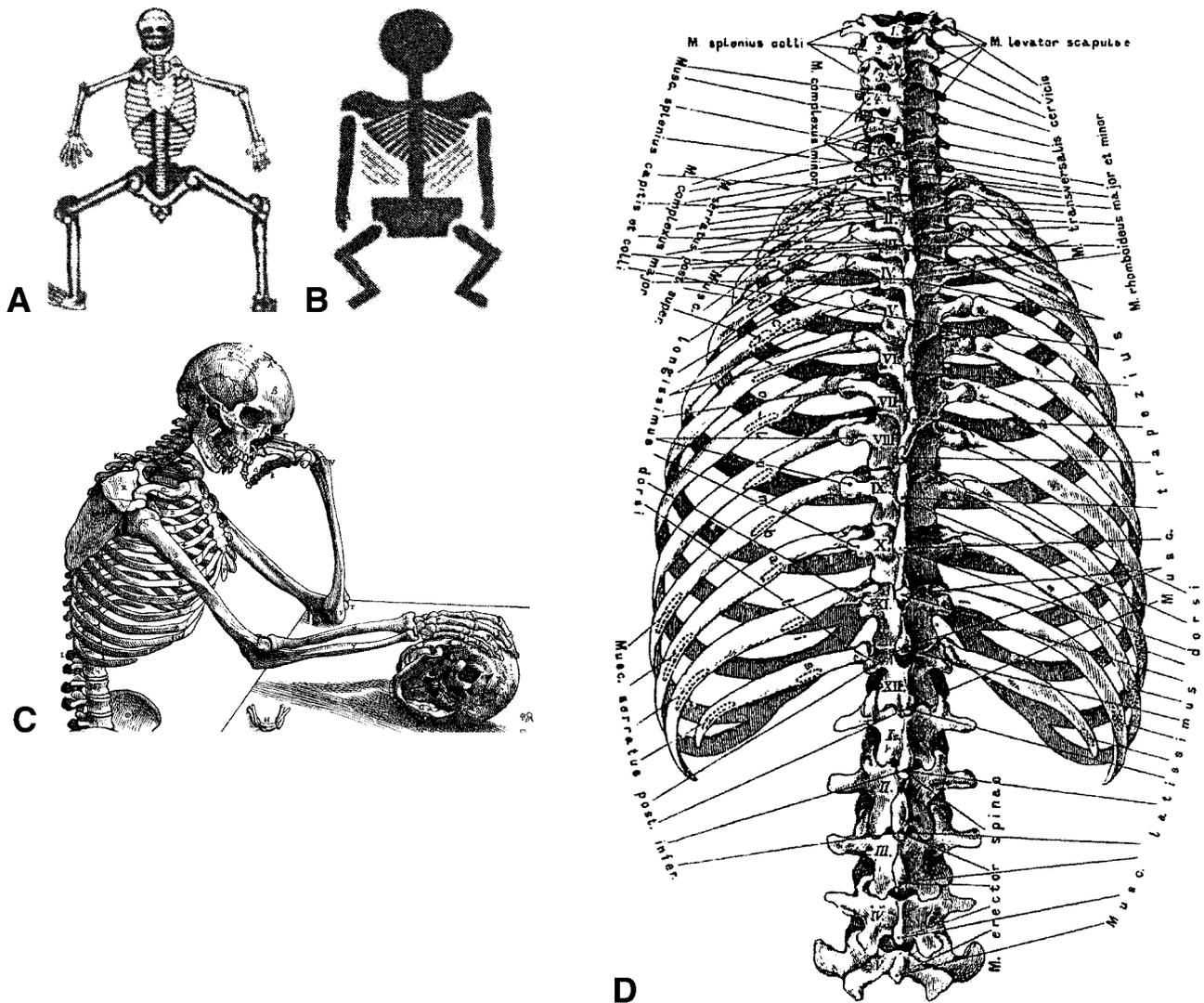


Figure 3. Ideogrammatic schema rather than detail in earlier scientific anatomical drawings: what is the rib cage? A,B: medieval ideas; B: Vesalius' Hamlet and the deeper meaning of death; C: a modern (19<sup>th</sup> Century) mechanical view showing all the "scientific" details (Sources: A, B, D,<sup>4</sup> C<sup>7</sup>).

grees are required for induction into the guild. Popular science ensures its dominance in the public arena, as can be seen today on *Nova* and in the *Times*, through oversimplified, emotive vividness, personal narrative, and gossipy controversies to lionize figureheads for the prevailing view (e.g., Wassermann, Pasteur) and promote enthusiasm for the accepted theory. Isolated facts are fitted gropingly to the theory in professional journals, and stereotypical digests are then built into textbooks, handbooks, or laboratory manuals that inculcate new students. The latter are often out of date even when published.<sup>7</sup>

Fleck goes to some lengths to show how scientific illustrations are *ideograms* of the accepted view. Here he chooses examples of anthropological interest. He compares anatomical drawings from medieval times to the present (for a visual tour of this fascinating history see [www.nlm.nih.gov/exhibition/dreamanatomy/da\\_intro.html](http://www.nlm.nih.gov/exhibition/dreamanatomy/da_intro.html)). The earlier drawings were *functionally* schematic. For example (Figure 3), 12<sup>th</sup> Century figures show the thorax as a figurative rib "cage," while in 1543 Vesalius drew a death-metaphor that obscured anatomic details. Today we feel it is "scientific" to know those details, but Fleck notes that this

requires much advance preparation and decision-making (e.g., dissecting away all material but the skeleton, leaving the cartilage but not intercostal muscle, membranes or ligaments, identifying muscle attachments) that makes the result a product of our current view of what the skeleton "is."

### BUT TOASTERS WORK!

Fleck and many analysts since Kuhn have stressed the ways historical context leads a view to become accepted, and that the accepted view is not the only possible one. The inculcation process converts observations

into “facts” that define what is “true” because the thought collective agrees about them. This leads historians, biographers, and philosophers to proclaim the fallibility of science, that scientists are but arbitrary products of their times, or even that the only Truth we approach is that of our own vested interest.

There is some merit to these allegations, but scientists do not cling to their belief system only out of ideology or caprice. Science has grown to predominance because, as one of my students put it, “toasters work.” But does this mean that we understand the *real* nature of metals (bimetallic thermostats), polymers (plastic knobs), and electrons (heating elements)? Or is a toaster simply well within the empirical predictive power of our experience? Similarly, the Wassermann test has successfully diagnosed exposure in many thousands of instances, and nobody questions a relationship between the pathogen and symptoms. So are we really being misled in any important way by our collective ideologies? Is it of more than mild historical interest why or that we view the pathogen as “the cause” of AIDS or syphilis?

We still seek point causes today, but they are a different kind of scourge: bad behavior or bad genes. The middle 20<sup>th</sup> Century proclaimed the conquest of infectious disease, and our biomedical fixation moved dramatically, first to environmental, and then to genetic causation, the idol of today’s biological thought collective. To paraphrase Shaw, when there is no gene we assume that since no disease can exist without such a gene, it must simply be eluding observation. In the sense that theory and fact are inseparable, the assumed gene is considered fact—we even name the gene for the trait—when it has not yet been identified (genes “for” dyslexia, homosexuality, and diabetes are examples).

Every issue described here in regard to infectious causation also applies to current genetic view of disease causation. We develop DNA (blood) tests to detect mutations in clear-cut cases, but genetic causation is far less clear in most cases, because a person can have the symptoms without the allele or the allele without the symptoms, and the symptoms are highly variable

and sometimes indefinitely delayed. There are countless examples, but our determination to find genes is unchecked.<sup>8</sup> Ironically, in having our collective heads turned the genetic way, we may be overlooking elusive *infectious* pathogens responsible for many chronic diseases after all.<sup>9,10</sup>

Evolutionary theory may be especially vulnerable to these kinds of ideological problems, because inferences that deal with the unobservable past have to be so highly indirect. The way we apply genetics to adaptive arguments, for example, rests heavily on theory.<sup>7</sup> This applies to anthropological interests, and in my next installment I’ll look at another anatomical example raised by Fleck: the structure of the human brain, in the subtle lights and shadows of evolutionary theory.

In regard to progress, scientists when pressed often claim that all we’re trying to do is to develop better predictive approximations. But deep down, we act as if we believe, and many assert that we’re approaching the real truth. Whether or not that’s an illusion, it is a powerful motivator. But there are often alternative explanations. Wassermann and his contemporaries “tuned” their work to melodies to which they could resonate. Exceptions were overlooked, ignored, or rationalized, and experiments designed that left little room for alternative interpretation. The same kind of phenomenon as been observed in ethnology and archeology, such as what the “facts” are regarding sophisticated pre-Columbian Amazonian culture and technology,<sup>11</sup> or whether behavioral evolution explains why (or that?) the Yanomami are “the fierce people.” Kuhn notes that scientists struggle to accommodate “anomalies” that are “reinterpreted to make them conform.” Almost all theories “contain some element of wishful thinking by their scientific proponents.” That’s not what engineers do: they build in empirical safety factors so they need not worry about the ultimate theory, because they really *are* just trying to make toasters that work.

The point is not that a given view of the world is superficial or wrong, but that it is somewhat arbitrary and contextual and neither necessarily more true than alternative views, nor a step

on a path to the presumed absolute truth. But the chosen view of the world can have impact beyond the mere intellectual imprisonment of ideas. For every path taken there is a path not taken. For example, putting our effort erroneously into genetics when environment or infection are the more important cause of disease, or misapplying evolutionary theory to justify racial profiling, would be detrimental to knowledge and our own society.

In practice, organized science may depend upon thought-collectives—theory, paradigms, or even ideology. But if these are cultural artifacts, and the best we humans can actually achieve is an approximation with predictive value but unknown relevance to truth, then the art-of-fact may be what counts most in science.

## NOTES

I welcome comments on this column: kenweiss@psu.edu. I have a feedback page at [www.anthro.psu.edu/rsrch/weiss\\_lab/index.html](http://www.anthro.psu.edu/rsrch/weiss_lab/index.html). I thank Anne Buchanan, Malia Fullerton, Nancy Tuana, and John Fleagle for critically reading this manuscript, and Dom Eggart on toasters.

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