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THEORIZING BALLISTICS: ETHICS, EMOTIONS, AND WEAPONS SCIENTISTS

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ABSTRACT

What is violence? This article explores conceptions of violence from the perspective of scientists engaged in weapons research. Ballistics scientists are routinely excluded from the "violent" label on grounds of class, status, education, and emotional comportment. The article analyzes the science of ballistics through the lenses of ethics and emotions. How do scientists justify experiments in ballistics, or the science of designing weapons and other technologies aimed at destroying environments and inflicting wounds (often fatal) and other forms of injury on people and nonhuman animals? In stark contrast to those who analyze weapons development as an objective science and who impart violent agency to autonomous technologies, I situate wound ballistics as a branch of applied moral philosophy. Its practice always involves an "ought." Although the central job of ballistics scientists is the "effective production of wounds," this is not regarded as violent, except by their victims, of course. In part, this lacuna is due to an ideological relationship forged between "violence" and particular emotional states. It is also part of a political project defining "the human."

Keywords: violence, ballistics science, scientists, war, weapons, emotions, ethics, human, humanity

Ballistics science is a feminist issue. As the scientific discipline committed to devising and producing weapons aimed at destroying environments and sentient beings, ballistics research goes to the heart of what it means to be human, in all our fleshly vulnerability. An analysis of the practices of ballistics scientists also exposes some of the incongruities inherent in the concept of violence. What is "violence"? There is no easy answer: "violence" is constituted through discursive practices and configurations. Acts are designated "violent" through processes of classification and regulation, generated by a vast array of agents, including public commentators, politicians, lawmakers, military officers, and academics, to name just a few. It makes a difference *who* is entitled to label something as "violent," which is why it matters that, for centuries, deciding whether an act is violent or not has been the task of white, middle- and upper-class men and their representatives within political, judicial, scientific, and military institutions. When victims maintain that specific acts are "violent," their claims are routinely disparaged, silenced, and suppressed.

In this article, I turn to one group of people routinely excluded from the "violent" label on grounds of class, status, education, and emotional comportment:

that is, men (almost exclusively) who "go ballistic." I am referring to ballistics scientists. When these highly educated professionals engage in war-work they have usually been deemed to be conducting acts of dispassionate research, rather than reveling in what are intrinsically violent provocations and practices. Their omission from the canon of violent individuals is no coincidence: it is an integral part of the necro-political complex.

In the spring and summer of 1947, a bad-tempered argument erupted in the pages of *The American Scholar*. It concerned the role of scientists in the development and production of weapons. The debate was sparked by a short article by Louis N. Ridenour, a professor of physics at the University of Pennsylvania who had spent the war conducting military research on radiation and radar. The article and the eleven responses that followed were entitled "Should the Scientists Resist Military Intrusion?" Later that year, these essays were republished in the *Bulletin of the Atomic Scientists* under the headline "Military Support of American Science, A Danger?"[1]

The Second World War had ended two years earlier, but Ridenour argued that continued military funding of research in weapons design was not only financially necessary but intellectually beneficial as well. The armed services, he claimed, were "fulfilling a public responsibility in supporting disinterested scientific research" and were careful not to "intrude" in decisions made within laboratories. He lambasted scientists who believed that any research that aided the armed forces was "*ipso facto* reprehensible." This was a ridiculous position, he fumed, and would lead to "logical absurdities." For example, was it "moral to pay federal taxes, when so large a fraction of the money so collected goes into maintaining the Armed Forces?" And what about starting a family? After all, "If a man begets children, and one of them is male, and there is a war, and this son is a soldier, sailor or airman, then he may kill others." Does this mean that a man should "forego procreation?"[2]

Ridenour challenged scientists who possessed misgivings against weapons research to simply refuse to conduct such research. They were not being *forced* to accept the money, he insisted, contending that "seduction is involved, not rape." The important "moral issue," Ridenour continued, was not what *type* of weapons were invented by scientists and then employed in armed conflicts but "whether a war be fought at all." After all, "God told Moses not to kill; in no way did he indicate that one form of killing is less moral than another." Ridenour urged scientist-citizens to "concentrate on [eliminating] war, and forget about the tools": in other words, they should not fret about their role in designing weapons aimed at maiming and killing fellow humans. It was important not to "confuse the rather minor matter of weapons design with the basic and tremendous immorality of war." Scientists had done a grand job in designing weapons during the 1939–45 conflict: now was not the time to develop scruples.[3]

1. Louis N. Ridenour, "Should the Scientists Resist Military Intrusion?," *American Scholar* 16, no. 2 (1947), 213-218. Also published as "Military Support of American Science, A Danger?," *Bulletin of the Atomic Scientists* (August 1947), 221-223.

2. Ridenour, "Should the Scientists Resist Military Intrusion?," 216-217.

3. *Ibid*., 217.

Respondents to Ridenour's article were divided, but the most revealing reactions came from his critics. They presented a significantly more hostile perspective on the relationship between science and weapons design. Vannevar Bush, who had been director of the Office of Scientific Research and Development (OSRD) since 1941, noted that the "great emphasis on applied research" (that is, weapons development) was "natural and proper" during wartime but should be abandoned in times of peace.[4] Philip Morrison, a physics professor from Cornell University who had worked with the Chicago and Los Alamos laboratories during the Manhattan Project, accused the military of using science with "crass inhumanity." He pleaded with scientists to pursue "truth for all men, not for Americans alone."[5] Mathematician Norbert Wiener also urged scientists to distance themselves from the military. He noted that "the Armed Services are not fit almoners for education and science. They are run by men whose chief purpose in life is war, and to whom the absence of war . . . is a frustration and denial of the purpose of their existence." Being paid by them was "fatal to the moral responsibility of the individual scientist."[6]

The most powerful riposte, though, came from sociologist Robert K. Merton. He sneered at Ridenour's naiveté, especially his belief that scientists could refuse "to be seduced into a life of secrecy by the munificent military" and would therefore "enjoy complete safety from rape by the men in uniform." Merton even accused scientists tempted by military grants of being prostitutes whose "behaviour testifies that eventually they would have given way to temptation." Weapon's research was a dishonorable task for scientists, and, Merton maintained, Ridenour's portrayal of a "disinterested, self-denying, unintrusive, prosperous, munificent and communicative military" was absurd.[7]

This heated exchange exemplifies some of the themes explored in this article. First, none of these commentators explicitly linked scientific war-work with real violence against sentient humans: the visceral, bloody consequences of their research were silenced by them all, irrespective of whether they supported or railed against Ridenour's pro-military stance. Second, with the exception of Merton, all of the commentators had been implicated in weapons development during the Second World War, yet they uniformly sought to position themselves as members of a disinterested and dispassionate elite. They presented themselves as men who not only possessed unique, specialist knowledge, but were also unaffected by political or personal emotions. Although committed to the task of fighting Axis militarism, each of these scientists claimed to adhere to an internationalist view of "humanity" and its corollary ethical attitude, the "humane." Their disagreement focused solely on the role of weapons research in peacetime.

4. Vannevar Bush, no title, *American Scholar* 16, no. 2 (1947), 219-220. Also published in the *Bulletin of the Atomic Scientists* (August 1947), 228.

5. Philip Morrison, no title, *American Scholar* 16, no. 2 (1947), 218-219. Also published in the *Bulletin of the Atomic Scientists* (August 1947), 224.

6. Norbert Wiener, no title, *American Scholar* 16, no. 2 (spring 1947), 220-21. Also published in the *Bulletin of the Atomic Scientists* (August 1947), 228.

7. Robert K. Merton, no title, *American Scholar* 16, no. 3 (1947), 356-357. Also published in the *Bulletin of the Atomic Scientists* (August 1947), 225.

In contrast, in this article I argue that discourses of "humanity" (both as ontology and moral attitude) are at the heart of the ideology and practice of ballistics science. I explore the regimes of normativity that develop within a discipline dedicated to the task of destroying "the human," yet whose members are not designated "men of violence." In other words, while ballistics scientists are heavily implicated in the major forms of wounding and killing in modern history, they have been excluded from the negative category of "violent." When defined in terms of interpersonal acts, the verb "violent" is applied to certain nonhuman animals, working-class criminals, combatant soldiers, and overly emotional militarists (to take just four examples), but not to affluent scientists responsible for weapons of mass destruction. In contrast, their instrumental violence is highly valued, lucrative, and valorized by elites within Anglo-European societies.

I will be analyzing the science of ballistics through the two lenses provided by Ridenour and his respondents: ethics and emotions. Both these frameworks (and I do not claim they are the only ones) are implicated in the inability to see the violence of ballistics scientists. First, historians need to be critical ethicists, refusing to accept the self-representation of ballistics scientists. I argue that scientists engaged in ballistics research are moral agents, making normative judgments about the ontological status of sentient beings. This includes judgments about life and death. These judgments should be seen as intrinsically violent. Second, the "violent" label is associated with a particular kind of emotionality ("hot") and expressive demeanor (belligerent). In contrast, scientists position themselves as "cool" and analytical. I argue that ballistics scientists are enmeshed in emotional communities. Mathematical precision, chemical formulas, and an abiding concern with reproducibility seek to disguise the emotionality at the core of their discipline. Although this article will focus solely on the scientists themselves, it decenters their rhetoric by implicit acknowledgment of their victims: it seeks to put violence and the abject body back into ballistics science. This is why ballistics should concern feminists.

The term "ballistics" comes from the Greek "ballein," meaning "to throw so as to hit." As a fairly recent scientific discipline, it is typically divided into three branches: interior, external, and wound ballistics.[8] Interior ballistics concerns itself with the inner mechanism of weapons (including barrels, armor systems, sights, muzzle attachments, systems technologies, and so on); external ballistics focuses on the effects of wind, velocity, gravity, and drag on the projectile in flight; and wound (also, chillingly, known as terminal) ballistics is the study of what happens when the missile hits its "target." The science of ballistics, therefore, involves designing weapons and other technologies aimed at destroying environments and inflicting wounds (often fatal) and other forms of debilitation (including psychological) on people and nonhuman animals. In the period explored in this article, scientists engaged in weapons research usually possessed expertise in physics, chemistry, metallurgy, mathematics, electrical and mechanical engineering, computing, and biology. As zoologist Solly Zuckerman (later,

8. Less frequently, some commentators also add intermediate ballistics, or the behavior of projectiles as the projectile leaves the barrel.

Lord Zuckerman: Britain's most prominent pioneer of "operational research" in the 1940s) proudly claimed, they were "professional students of destruction."[9]

Although the scientists I will be discussing conducted their weapons research in the UK and US between the mid-nineteenth and the mid-twentieth centuries, it is no coincidence that I started this article with the Second World War. That war was a crucial period for ballistics science, seeing not only unprecedented military activity by scientists but also transforming the dynamic between professional and "lay" weapons researchers. Science itself (as opposed to a specialist *branch* of science) became fully militarized from the late 1930s, heralding a revolution in military affairs. Indeed, none of the scientists responding to Ridenour's article in 1947 would have considered themselves to be full-time ballistics scientists. They engaged in weapons research because of the international emergency occasioned by Axis aggression. They probably would have argued that they produced forms of militarized knowledge that were *intrinsically* ethical because of a specific historical context, that is, global war.

This insistence on the contextual specificity of scientific research in weapons design and production sits uneasily with their simultaneous naturalization of militaristic violence. These scientists routinely situated their task as part of a timeless trajectory of what it means to be human, at least for the masculine gender. In a typical statement, published in the classic text *Wound Ballistics*, Major Ralph W. French and Brigadier-General George R. Callender maintained that "analytical retrospective of the entire development of warfare from prehistoric time" onward reveals "man's continual struggle to augment his human capacity to inflict injury through the utilization of the law of kinetic energy as applied to the moving object."[10] In other words, they contended not only that ballistics science was objective, rational, and concerned with falsifiable hypotheses, but they also naturalized and universalized violence as part of "man's" nature. This enabled them to sidestep ethical debates about the conditions under which wounding and killing was (or was not) morally justified.

When ethical issues did arise, distinctions were made between times of war and peace. This was the point made by many of Ridenour's critics. The most pressing of these issues was the appropriate "medium" for experimentation. In the absence of battlefield action, ballistics scientists lamented the dearth of human subjects on which they could explore the "wounding effectiveness" of their weapons.[11] They were required to develop alternative mediums with which to "standardize the production" of "wound events." Substitutes for human and nonhuman bodies included water, plasticine, clay, blocks of gelatin, glycerine soap, silicon, synthetic fibres, leather, latex, and pine boards (dubbed "Zuckerman soldiers").

9. Solly Zuckerman, *From Apes to Warlords: The Autobiography (1904–1946) of Solly Zuckerman* (London: Hamish Hamilton, 1978), 334.

10. Major Ralph W. French and Brigadier-General George R. Callender, "Physical Aspects of the Missile Casualty," in *Wound Ballistics*, ed. Lieutenant-Colonel Leonard D. Heaton (Washington, DC: Office of the Surgeon General, Department of the U.S. Army, 1962), 92.

11. Gwilym G. Davis, "The Effects of Small Calibre Bullets as Used in Military Arms," *Annals of Surgery* 25, no. 1 (January 1897), 36.

In more recent decades, "biomechanical models" (such as the "Computer Man") were employed.[12] Such forms of modeling were violent only in symbolic realms.

Less abstract forms of violence occurred when ballistics scientists tested their weapons on the sentient, anesthetized, and dead bodies of nonhuman animals. In 1899, rifle and bullet researcher Henry G. Beyer boasted that his experimental subjects were freshly killed animals, still "perfectly fresh" and "warm" when delivered to his laboratory from the local abattoir.[13] At other research facilities, scientists preferred anesthetizing their animals prior to weapons testing, debating only how much anesthetic should be given to animals before they were "sacrificed."[14] Still other scientists (including Zuckerman) believed that only fully sentient animals would suffice. He experimented using living and fully sentient monkeys and goats.[15]

The "gold standard" of testing, though, involved human subjects. War itself provided many opportunities: as distinguished physician Henry K. Beecher bragged during the Second World War, battle meant that there was "an abundance of material" at the "active fronts."[16] Here, debates about gradations of humanity and its related ethical attitude (the "humane") were glaringly revealed. Weapons designers explicitly argued that certain weapons were legitimate when employed against "savages," but were cruel in conflicts between "civilized" peoples. In imperial conquests, for instance, the enemy was "fair game." This was why missiles that had been designed to kill the "charging tiger, elephant, or buffalo" were essential in armed conflicts against a "fierce and tiger-like" human enemy, according to one late-nineteenth-century ballistics expert.[17] Ballistics developers need not hold any scruples in developing weapons that were intrinsically vicious, because "savages" either did not fully feel pain or were set outside the international conventions against unnecessarily cruel punishments. In the words of Surgeon-Colonel William Flack Stevenson in his 1898 report on the need to develop bullets with greater "stopping power,"

> the fanatical Asiatic knows nothing of [international] congresses, and would only laugh at the suggestion of waging war on such principles. All his efforts are directed towards causing the greatest possible injury to his enemy, and he fully expects his enemy to do likewise by him. No purely humanitarian sentiments, therefore, need interfere with the use of bullets of a destructive nature by civilised nations when at war with people of this class.[18]

12. V. Clare, W. Ashman, P. Broome, J. Jameson, J. Lewis, J. Merkler, A. Mickiewicz, W. Sacco, and L. Sturdivan, "Computer Man Simulation of Incapacitation: An Automated Approach to Wound Ballistics and Associated Medical Care Assessments," *Proceedings of the Annual Symposium on Computer Application in Medical Care* 4 (November 1981), 1009-1013.

13. Henry G. Beyer, "Observations on the Effects Produced by the 6-mm Rifle and Projectile—Experimental Study," *Journal of the Boston Society of Medical Sciences* 3, no. 5 (January 1899), 126.

14. For example, see Major F. P. Thoresby, "Armalite Rifle (AR15) Wound Ballistics Trials," Porton Technical Paper No. 904, Secret—Discreet, 1964, np, in The National Archives (UK), WO 189/160.

15. Zuckerman, *From Apes to Warlords*, and Solly Zuckerman and A. N. Black, "The Effect of Impacts on the Head and Backs of Monkeys," typescript, August 1940, SZ/OEMU/8/3/18.

16. Letter from Henry Beecher to A. N. Richards, October 16, 1942, in Folder 10, Papers of Walter B. Cannon, Countway Medical Library, Boston.

17. Alex Ogston, "Continental Criticism of English Rifle Bullets," *British Medical Journal* (March 25, 1899), 752.

18. Surgeon-Colonel William Flack Stevenson, "Statement on the General Question of the 'Stopping Power' of Modern Small-Bore Bullets," 25-6 [p. 39-40 of file], in The National Archives (London) WO 32/7055.

Writing from the 1899 Peace Conference, army surgeon Frederick George Engelbach made a similar argument, based largely on the reduced sentience of a "savage" enemy. What can be done, he concluded, "with a gallant fanatic who actually wriggles up the lance of his enemy to slay before his exhausted muscles give out?"[19] The Director-General of the Indian Medical Service put it more evocatively: a "fanatical Ghazi," he judged, "was not checked by the modern bullet, which went through him like a knitting needle through a pot of butter."[20] They were advocating the use of soft-point or dum-dum bullets, which inflicted devastating wounds.

The violence of such discussions between munitions scientists is transparent: their language is vehement, brutal, and passionate. Such rhetoric was dramatically muted when these scientists discussed weapons designed for fighting "civilized" nations. In such cases, a mathematical logic was typically adopted, but that should not mask their equally violent intent. Instead of discussing the need to intensify the suffering of certain groups of people, ballistics scientists turned to more abstract formulations such as SCRs and SKRs, that is, Standardized Casualty and Killing Rates. Devised by Zuckerman and statistician Frank Yates, these rates are based on a population density of one person per thousand square feet (or 92.9 square meters) in the area at risk. For example, they calculated that when the atomic bomb was dropped on Hiroshima, the "vulnerable area for the killed was 2.85 square miles, and for all casualties 9.36 square miles. This gave a SKR of 79,450 and an SCR of 260,900." They also developed "indexes of wounding capacity" in their attempt to discover how "the desired wounding effect could be achieved."[21] In 1977, the author of "Wound Ballistics" added that in calculating an "index of wounding capacity" it was helpful to know the "level of energy absorption at a tissue depth of 15 cm . . . as this is the depth at which most vital structures lie."[22] The ability of these scientists to convert multiple observations into abstract formulas won them prestige, but also served to mask the violence involved in calculating how to ensure this "desired wounding."

Of course, the ballistics value of using human bodies to calculate how to inflict suffering did not occur only in wartime. In peacetime, human cadavers were "harvested" from poor-law institutions and pauper hospitals: these marginalized bodies, unmourned by relatives or friends, could be further set outside the community of "fully human" by ballistics experimentation.[23]

A cavalier attitude to consent was also common when living humans were used. This was most egregious when American scientists made use of Nazi experimental

19. Frederick George Engelbach, "A Plea for the Dum-Dum," *Daily Mail* (June 12, 1899), 4.

20. Comment by the Surgeon-General Harvey (Director-General of the Indian Medical Service), in discussion after the lecture by William MacCormac, "Some Remarks, By Way of Contrast, On War Surgery, Old and New," *British Medical Journal* 2, no. 2121 (1901), 462.

21. A. A. Liebow, "Encounter with Disaster: A Medical Diary of Hiroshima, 1945," *Yale Journal of Biology and Medicine* 56, no. 1 (1983), 235. Also see Wilfrid Edward Le Gros Clark, "The Contribution of Anatomy to the War," *British Medical Journal* (January 12, 1946), 40, and Charles N. Bressel, "Expected Target Damage for Pattern Firing," *Operations Research* 19, no. 3 (1971), 655.

22. J. Wilson, "Wound Ballistics," *West Journal of Medicine* 127 (July 1977), 51.

23. Colonel Louis Anatole LaGarde, *Gunshot Injuries: How They Are Inflicted, Their Complications, and Treatment* (New York: William Wood and Co., 1914), 417.

"data" after the Holocaust.[24] But such carelessness can be traced in other research facilities as well. Take, for example, chemical warfare experiments carried out in both British and American laboratories during wartime. A particularly revealing account was given in 1946 by Harry Cullumbine, head of the Physiological Section at the Chemical Defence Experimental Station at Porton Down. He had been conducting tests of lacrimators (weeping agents), sternutators (sneezing agents), and "vesicant" (blistering) compounds, such as mustard gas.[25] Although Cullumbine claimed that "all the subjects were volunteers," this was disputed by the chemist George Box, who worked as a lab assistant there. Box recalled that when testing liquid mustard gas on soldiers, everyone had to "sign off on a line that said 'All informed,' but I'm afraid this protocol was not followed." He noted that "Cullumbine . . . was kept very busy by the misuse of these samples."[26] An independent ethics committee was established at Porton Down only in 1988.[27]

So, how did ballistics scientists justify conducting research intended to harm other people? One important way was to establish boundaries, particularly between themselves as "innocent" or "pure" scientists and "guilty" military men. When criticized, ballistics scientists routinely responded by arguing that they could not control the *way* their inventions (conveniently not called "weapons") were employed. Even Louis F. Fieser, when asked about his ethical responsibility for inventing napalm, maintained that "I have no right to judge the morality of napalm just because I invented it." When questioned about its use during the war in Vietnam, he claimed that "You don't know what's coming. I was working on a technical problem that was considered pressing."[28]

Others abnegated responsibility for the intrinsically violent nature of their work by claiming dual use. In the words of Cullumbine, the "offensive tests" (that is, experiments that seek to develop the most devastating chemical weapons) were a "necessary preliminary to experiments designed to evaluate protective measures and equipment; the possible hazards had first to be determined before methods of defence could be formulated."[29]

However, the relative *weight* of humanitarian versus antihumanitarian values was summed up by French and Callender in *Wound Ballistics* (1962). After genuflecting toward the humanitarian goals behind ballistics research (that is, such knowledge will help medical officers treat the wounded), they quickly turned to its darker goals. "This knowledge," they bragged, "permits the design of ordnance material for antipersonnel purposes on scientific grounds." It "also lessens

24. For a discussion, see Benna Müller-Hill, "The Silence of the Scholars," in *Dark Medicine: Rationalizing Unethical Medical Research*, ed. William R. LaFleur, Gernot Böhme, and Susumu Shimazono (Bloomington: Indiana University Press, 2007), 57-62.

25. Harry Cullumbine, "Chemical Warfare Experiment Using Human Subjects," *British Medical Journal* 2, no. 4476 (1946), 577.

26. George E. P. Box, *An Accidental Statistician: The Life and Memories of George E. P. Box* (Hoboken, NJ: John Wiley and Sons, 2013), 29.

27. Hugh Dudley, "Tests on Volunteers at Porton Down," *British Medical Journal* 309 (November 26, 1949), 1443.

28. "The Man Who Invented Napalm," *Time* (January 8, 1968), 33.

29. Cullumbine, "Chemical Warfare Experiment Using Human Subjects," 578.

the need for costly rule-of-thumb or 'cut and try' methods by either the military surgeon or the ordnance engineer."[30] The "fog of war" would be dispelled.

Scientists used another tactic to justify ballistics research: relativism. Cruelty was "comparative"; pain could be calibrated. As Ridenour put it at the beginning of this article, "God told Moses not to kill; in no way did he indicate that one form of killing is less moral than another."[31] They asked: were the wounds inflicted by hollow-point bullets actually more agonizing than those caused by the Snide or Martini-Henry?[32] Was it really more terrible to be burned alive with napalm than with conventional fire? Was drowning worse than dismembering? For example, Surgeon-Major-General J. B. Hamilton defended the development and employment of dum-dum bullets on the grounds that there were worse ways to die. He observed that an admiral in command of a fleet would never "hesitate to 'ram' a battleship or blow her up with a torpedo, destroying perhaps 800 men in the operation." Indeed, he exclaimed, such an admiral would "gain renown for the action; but if our War Office uses a projectile calculated to 'stop' individuals, it is condemned as 'inhumane'!" He reminded readers that "war cannot be made with rosewater."[33]

Ballistics scientists could even be heard arguing that certain types of violence were "humanitarian." Again, this was Hamilton's point. Using the euphemistic term "setting up" to refer to what happens when a bullet penetrates human flesh, he noted that "If the Dum-dum bullet be used, it, as a rule, will injure but one man, as when 'set up,' its power of penetration rapidly ceases; if, on the other hand, a projectile entirely covered with nickel be employed, it will possibly pass through two or three men, and gradually 'setting up,' inflict greater injuries on a fourth."[34]

In his article entitled "How To Fight Savage Tribes," Elbridge Colby similarly argued that the mass slaughter involved in dropping a bomb on a village was "actually humane" because it would shorten the conflict and thus prevent "the shedding of more excessive quantities of blood."[35]

It was a calculus perfected by humanitarian organizations such as the International Committee of the Red Cross from the late twentieth century, who devised the Wound Classification System and SIrUS Project (Superfluous Injury or Unnecessary Suffering Project). The formula's proponents boasted that it provided an "objective" way of judging wounds. The number and size of wounds were measured; fractures, recorded; injuries to vital structures, noted; the presence of metallic bodies, counted; and the length of time spent in hospital,

30. Major Ralph W. French and Brigadier-General George R. Callender, "Physical Aspects of the Missile Casualty," in Heaton, ed., *Wound Ballistics*, 93.

31. Ridenour, "Should the Scientists Resist Military Intrusion?," 218.

32. For an extended discussion, see Surgeon-Colonel W. F. Stevenson, "The Effects of the Dum-Dum Bullet from a Surgical Point of View," *British Medical Journal* (May 21, 1898), 1324-1325; "The Peace Conference," *British Medical Journal* (June 10, 1899), 1420; "The Text-Book for Military Small Arms and Ammunition 1894," *Quarterly Review* 190 (July 1899), 174-175.

33. Surgeon-Major-General J. B. Hamilton, "The Dum-Dum Bullet," *British Medical Journal* (June 11, 1898), 1559.

34. *Ibid*.

35. Elbridge Colby, "How to Fight Savage Tribes," *American Journal of International Law* 21 (1927), 279-281, 284-285, and 287.

assessed.[36] Although the benevolent motives of those experts who devised such codification practices is unquestioned, the procedure actually serves a political function in *justifying* certain technologies designed to maim and kill. Even proponents of SIrUS argue that conventional weapons do *not* violate the criteria for "superfluous injury or unnecessary suffering." In other words, both the Wound Classification System and SIrUS establish a hierarchy by which certain weapons designed to maim and kill people are acceptable. It reproduces an ethic willing to minimize, not eradicate, certain forms of violence. As the first sentence of an article on the Wound Classification System states, the "use of weapons by human beings to inflict physical harm on each other is an integral part of our heritage, and likely predates the development of speech."[37] Such assumptions return us to the universalistic discourses of ballistics specialists such as French and Callender.

To a large degree, these justificatory performances are ideological. But they are also shaped by beliefs about the value of sacrificing personal preferences in the interest of scientific progress. I can illustrate this point by turning to the prominent chemist Louis Fieser. During the Second World War, Fieser specialized in developing incendiary devices. He was also the inventor of napalm. In his memoir, however, he complained that, in 1941, he had been "instructed to terminate work on explosives and to work instead on poison gases, vesicants." The reassignment "did not please me," he recalled, because he "doubted very much that vesicants would be used in the war," he "would much prefer to work on something of practical value to the war effort." Equally important, he maintained that "use of poison gas seemed to me inhumane." In the end, however, "I swallowed my personal feelings and engaged a new group of men to start research on vesicants."[38] His concerns about the "inhumanity" of poisonous gases sit uneasily next to his lack of concern about burning people to death by fire and napalm (water boils at 100 degrees Celsius while napalm generates temperatures of 800 to 1,000 degrees). Indeed, in his memoir, he is extremely proud of the fact that the millions of "Napalm-filled M-69s . . . scored a high record of success in the bombing of Germany" and had a "superb record of success in the Pacific Theatre of Operations" as well.[39] By the end of the war, he claimed that "production of Napalm thickener had reaches a scale of about 75 million pounds a year" and "approximately 30,000,000 M-69 bombs had been produced."[40] He also remarked that although his scientific group had not adapted napalm for use in flame throwers, it was nevertheless "gratifying to us to learn" that other scientists had "found this particular gel ideally applicable" to "deliver[]" this "burning fuel . . . onto a distant target."[41]

36. See Robin M. Coupland, "The Red Cross Classification of War Wounds: The E.X.C.F.V.M. Scoring System," *World Journal of Surgery* 16 (1992), and ICRS, *SIrUS Project: Toward a Determination of Which Weapons Cause "Superfluous Injury or Unncessary Suffering,"* ed. Robin M. Coupland (Geneva: ICRC, 1997).

37. Captain (Reserve) Andrew W. Kirkpatrick, Rosaleen Chun, Lcdr (Navy) David Ross Brown, and Richard K. Simons, "Optimism about Superfluous Injury and Unnecessary Suffering: A System of Measurement with Potential for Controls," *Journal of the American College of Surgeons* 190, no. 4 (2000), 483.

38. Louis F. Fieser, *The Scientific Method: A Personal Account of Unusual Projects in War and in Peace* (New York: Reinhold Publishing Corporation, 1964), 14.

39. *Ibid*., 52.

40. *Ibid*.

41. *Ibid*., 52-53.

Such cognitive dissonance is typical. Another example could be the scientists at the Wound Ballistics Research Group who, during the Second World War, were responsible for placing wound ballistics "on a sound quantitative basis."[42] Physiologist Edmund Newton Harvey and neurophysiologist John Farquhar Fulton were prominent members of this group. Historians writing their memoirs and obituaries ignored their violence. Harvey was described as having a "pensive, almost poetic expression," and also of being a man with a "keen sense of ethics, a solid integrity, impeccable taste, and a dignified sense of humor."[43] Fulton was passionate about the pacifist writer Leo Tolstoy and was said to be "the foremost exponent of a union of medicine and the humanities, science, and history." He was also a gastronome and the founder of a major humanities library. As an admirer maintained in 1956, Fulton exuded a "humanistic approach" in his ballistics research and had the "satisfaction of indirect assuagement of human needs." He added that: "Like the father of daughters, his contributions will be found even where his name may not be known."[44] Inherent in such logic is the violent erasure of women as well.

The disconnect between the white-coated scientists working in prestigious laboratories and their "outputs" (weapons designed to harm others) is compounded by the obvious pleasure they take in their work. The emotional register of ballistics scientists is important in understanding why the designation "violent" is so rarely applied to them. In her chapter entitled "Experimental Injury: Wound Ballistics and Aviation Medicine in Mid-Century America," historian Susan Lindee argues that weapons scientists exemplified rational neutrality and the erasure of emotions.[45] This is misleading. Although ballistics scientists cast their findings in the abstract languages of mathematics and chemistry, the emotional register is evident in their drive to mastery and competence, their pride in belonging to an elite group, and their delight when successfully completing a set of experiments. It is not necessary to appeal to their letters and diaries—the "private self"—to explore the emotions of ballistics science since the scientific self is also a feeling self. The most heralded trait of scientists—"objectivity"—is itself an emotion involving a feeling of restraint and a striving for repetition.

The emotional economy of science takes a number of forms. First, the act of creating weapons elicits emotional conventions, including a disdain of "hot" language and a cultivation of composure. Second, emotional communities are forged through relationships with other scientists. The practice as well as the production of ballistics science is fundamentally social. Of course, there is a strong gender element to these social communities. For example, Fieser's wife, Mary, was a chemist and co-producer of his incendiary projects, but she was never identified

42. E. Newton Harvey, J. Howard McMullen, Elmer G. Butler, and William O. Puckett, "Mechanism of Wounding," in Heaton, ed.,*Wound Ballistics*, 146.

43. Frank H. Johnson, *Edmund Newton Harvey 1887–1959: A Biographical Memoir* (Washington, DC: National Academy of Sciences, 1967), 194 and 198.

44. Hebbel E. Hoff, "The Laboratory of Physiology," *Yale Journal of Biology and Medicine* 28 (December 1955–February 1956), 165.

45. Susan Lindee, "Experimental Injury: Wound Ballistics and Aviation Medicine in Mid-Century America," in LaFleur, Böhme, and Shimazono, eds., *Dark Medicine*, 121-137.

as a ballistics expert either at the time or since.[46] Irrespective of the existence of women in the laboratories, it was a very male project.

Third, ballistics scientists pay attention to the emotions of their victims. On the one hand, they are encouraged to view their victims as abstract formulas or in the form of the universal, immaterial "Computer Man." The pixeled computer screen also blurs the distinction between the life of the sentient body and the abstract one: biological and simulated existence becomes interchangeable. On the other hand, they are aware that their weapons needed to be noisy and awesome, as well as deadly, in order to incite terror in victims. Even Winston Churchill was aware that spreading "lively terror" was important to the British invasion of Mesopotamia (now Iraq) in 1919. It was this "moral effect" that would "cause great inconvenience" and enable them to achieve their goals, he maintained.[47] This "moral" effect of weapons design was often viewed as varying by culture. This has a strong racist undertone. For example, in his influential *The Reformation of War* (1923), Colonel J. F. C. Fuller claimed that "uncivilized" societies were "like the organism of the lower animals" in that they were "controlled by a series of nervous ganglia rather than a centralized brain." As a consequence,

> in small wars against uncivilized nations, the form of warfare to be adopted must tone [sic] with the shade of culture existing in the land, by which I mean that against peoples possessing a low civilization, war must be more brutal in type (not necessarily in execution) than against a highly civilized nation; consequently, physical blows are more likely to prove effective than nervous shocks.[48]

In other words, when fighting an "uncivilized" foe, weapons needed to be bolder and more brutal in order to produce the desired terror. Spectacle was paramount, particularly the awesome assault on the senses of touch, sight, smell, and sound.

Fourth, ballistics scientists were sensitive to the aesthetics of their designs, admitting to responding emotionally to balance and beauty. The pleasures of harmoniously designed weapons were told in over-blown, breathless, and vivid language. The techno-aesthetics of weapons design was enhanced by scientific visualization. Ballistics scientists were keen to use photography because it showed the "awesome" path of the bullet moving through its "medium" (that is, a substitute for human flesh). Through photography, the very "essence" of violence could be tracked, captured, measured, replicated, and analyzed.

There was also aesthetic pleasure to be had in witnessing destruction: the trajectory, spin, and "yaw" of a projectile, for instance. An example of this can be found in Lionel F. West's theory of wound ballistics, developed during the First World War. Drawing on A. M. Worthington's *A Study of Splashes*, West argued that there was a close comparison between splashes made by rainwater or spilled milk and those made when a projectile penetrated a human being. For

46. Fieser, *The Scientific Method*, 13-14 and 101. See Stacey Pramer, "Mary Fieser: A Transitional Figure in the History of Women," *Journal of Chemical Education* 62, no. 3 (1985), 186-191, which never mentions her involvement in her husband's incendiary research.

47. Churchill Papers, 16/16, May 12, 1919, cited in Derek Gregory, "In Another Time-Zone, the Bombs Fall Unsafely . . .: Targets, Civilians, and Late Modern War," *The Arab World Geographer* 9, no. 2 (2006), 91.

48. Colonel J. F. C. Fuller, *The Reformation of War* (London: Hutchinson and Co., 1923), 191.

him, wounds were like a "splash." As when milk was spilled, when a bullet enters human tissue, there is a "bubble stage," then the "thickening ring of upraised tissues will . . . break or tend to break into fragments or 'drops'." The bullet might "spin, wobble, or trip over itself at any velocity or angle" (and therefore the "splash" will be "rough") but the "general phenomena . . . will, considered generally, be the same."[49]

This blithe comparison of spilled milk and shattered tissue and bone encourages a kind of cognitive forgetfulness about the violent function of weapons. It is extremely common in ballistics literature. Ballistics experts talk about the "production of the wound"[50] or "producing the casualty"[51] as though mortal combat were some kind of industrialized assembly line. Hollow-pointed bullets were presented as simply being allowed to "'set up' on impact."[52] When such bullets hit a person, they "burr" before opening backwards.[53] The explosive effects of high-velocity missiles is described as being "disruptive."[54] *Objects* are described as being "wounded" while "kill probability models" are based on "round lethality on tank functionality" rather than the humans inside the tanks.[55] Fieser called napalm "apple sauce"[56]; it was a "*flak* suppression weapon," rather than a human-suppressor.[57]

Indeed, as I argue in *Wounding the World*, the leading analogies to wounding in the ballistics literature are water and snow.[58] Wound ballistics is described as "a branch of underwater ballistics,"[59] and damage to human tissues is described as similar to "the stream of water from a fire hose."[60] In 1941, when Zuckerman and his co-authors described a bullet entering a human body, they observed that when "the ball enters the target a tail splash develops."[61] This was also the language used by Harvey. Writing in 1948, he observed that:

49. Lionel F. West, "The Cause of the Divulsive Effect of Projectiles," *British Medical Journal* 1, no. 2873 (1916), 148. See A. M. Worthington's *A Study of Splashes* (London: Longman, Green, and Co., 1908).

50. Maj. Ralph W. French and Brig. Gen. George R. Callender, "Ballistic Characteristics of Wounding Agents," in Heaton, ed., *Wound Ballistics*, 111.

51. Major Ralph W. French and Brig.-Gen. George R. Callender, "Physical Aspects of the Missile Casualty," in Heaton, ed., *Wound Ballistics*, 115.

52. Hamilton, "The Dum-Dum Bullet," 1559. The term was widely used: see "The New Service Bullet," *British Medical Journal* 2, no. 1957 (1898), 39.

53. "The New Service Bullet," 39.

54. "Disruptive Wounds from High-Velocity Projectiles," *British Medical Journal* (December 20, 1941), 881.

55. Seth Bonder, "Army Operations Research: Historical Perspectives and Lessons Learnt," *Operations Research* 50, no. 1 (January-February 2002), 27.

56. Fieser, *The Scientific Method*, 28, 32, and 47

57. Michael Krepan, "Weapons Potentially Inhumane: The Case of Cluster Bombs," *Foreign Affairs* 52, no. 3 (1974), 598-599.

58. Joanne Bourke, *Wounding the World: How Military Violence and War-Play Invade our Lives* (London: Virago Press, 2015).

59. E. Newton Harvey, J. Howard McMillen, Elmer G. Butler, and William O. Puckett, "Mechanism of Wounding," in Heaton, ed., *Wound Ballistics*, 146.

60. Louis B. Wilson, "Firearms and Projectiles: Their Bearing on Wound Production," in *The Medical Department of the U.S. Army in the World War*, xi, pt. I (Washington, DC: Government Printing Office, 1927), 9-56, and E. Newton Harvey, J. Howard McMillen, Elmer G. Butler, and William O. Puckett, "Mechanism of Wounding," in Heaton, ed., *Wound Ballistics*, 144.

61. A. N. Black, B. Delisle Burns, and Solly Zuckerman, "An Experimental Study of the Wound

[w]hat happens with low velocity can be illustrated by thrusting a pointed rod into snow. The ice crystals are pushed ahead and move gently to one side leaving a track, perhaps somewhat larger than the rod, but with no effects at a distance. The high velocity missile, on the other hand, not only imparts momentum to material in front but also to material at the side, so that a great cavity is formed. . . . The effect can best be described as explosive.[62]

In the words of another ballistics expert, if a diver "chooses a 'cannonball' dive, he will create a larger splash immediately on entering the water. This is similar to a missile that assumes a larger diameter ('mushrooms' or doing a 'bellywooper') when coming into contact with tissue."[63] Such analogies are important: they exchange the messy, sticky bloodiness of actual wounding (not to mention the agonized victim) for a clean, gentle image of water or snow.

The removal of violence from the weapons designer is also achieved by giving agency to the weapon itself. Indeed, the term "terminal ballistics" is frequently described as the "behavior of the missile in tissue," as though a missile is capable of "behaving" one way or another.[64] Ballistics science itself is defined as a kind of "bullet–body interaction" in which there is an "exchange" of energy.[65] In such ways, the victim's flesh is portrayed as an active partner in the interactive wounding process: her body participates in "exchanging" energy with the missile. According to this way of speaking, weapons possess emotions. "Violent" weapons are those that are wielded *in a particular manner*: they could be "angry," "hot," and "intimate" or "instrumental" ("cool," "dispassionate," and "long-distance"). From this point of view, aggressive weapons are those wielded by the technological "have-nots" rather than those used by high-tech states. In other words, in ballistics narratives, weapons are deeply enmeshed in *individual* social relations (they interact with the bodies of victims and have emotional reactions to those victims), but they are curiously abstracted from wider political relations. The weapons, rather than their designers, act "violently."

Both the ethical contortions and emotional register of ballistics scientists can be illustrated by returning to Fieser's memoir. As already mentioned, during the Second World War, he was a leading expert in explosives and "hazardous chemicals," known most notoriously for inventing napalm. Fieser titled his memoir *The Scientific Method* because he believed that, whether in peace or war, science proceeds by looking "for a clue or for a working hypothesis," carrying out "experiments planned to exploit the clue or to test the hypothesis," and then "carefully observ[ing] and analys[ing] the results." This procedure is followed by planning "further experiments for advancement of the problem."[66] For him,

Mechanism of High-Velocity Missiles," *British Medical Journal* (December 20, 1941), 872. Also see J. Wilson, "Wound Ballistics," *West Journal of Medicine* 127 (July 1977), 53.

62. E. Newton Harvey, "The Mechanism of Wounding by High Velocity Missiles," *Proceedings of the American Philosophical Society* 92, no. 4 (1948), 2294.

63. Gary W. Dufresne, "Wound Ballistics: Recognizing Wound Potential. Part I: Characteristics of Missiles and Weapons," *International Journal of Trauma Nursing* 1, no. 1 (1995), 7.

64. Kathryn Moore, "The Knife and Gun Club Just Adjourned: Managing Penetrating Injuries in the Emergency Department," *Journal of Emergency Nursing* 38, no. 1 (2012), 102.

65. *Ibid*.

66. Fieser, *The Scientific Method*, 5.

there was no difference between devising weapons for military use (to which he devotes eighteen of twenty-three chapters) and making a "squirrel-proof bird feeder" (one chapter). Precision is crucial: Fieser's text is strewn with chemical formulas, scientific acronyms, and detailed diagrams. Footnotes carefully provide readers with the academic qualifications of every person he mentions. He values "objective comparisons" and "objective appraisal," and every component of his experiments are fastidiously calibrated, weighed, and assessed.[67]

But "objectivity" does not rule out emotion. Indeed, pleasure was the chief motive for writing his memoir in the first place. He wanted his book to "provide an entertaining and unorthodox demonstration of the scientific method." He hoped that it would enable readers to "take pleasure, as I have, in recollecting stimulating experiments out of the past."[68]

For Fieser, inventing explosives involved an "exciting line of experimentation."[69] He writes of "most impressive . . . performance[s]," which he eagerly photographs.[70] He describes starting some "beautiful fires" in a way that was "a real pleasure."[71] Ballistics experiments are of "considerable personal interest," leading rival scientists to engage in "competitions" with one another, after which they either celebrate or commiserate with one another in the "men's bar."[72] After the successful testing of a "500-lb. incendiary bomb of penetration power superior to that of any existing bomb," he simply exclaimed "Victory!" in his diary.[73] After using an incendiary on water, causing 40- to 50-foot-high flames along a 1,000-gallon oil slick, he tells us that his team were "happy and we had a gay party of celebration in the evening."[74] Cute names were given to explosives, including "Slick Mix" (for "batches of dried goop" intended to ignite on water); "City Slicker" for a box igniter; and "Paul Revere" (after a prominent officer of the American Revolutionary War) for a munition designed to ignite on land or sea.[75] When "released in clusters from a Torpedo Bomber," "City Slickers" were "a pretty sight."[76]

Crucially, the effect of his weapons on his victims is totally absent. Fieser is obviously aware of the terrifyingly destructive power of his weapons on human beings. His incendiary experiments even involved constructing realistic settings, including homes with domestic furniture, wallpaper, and "pretty-girl picture[s]" hanging on the wall.[77] It is no coincidence that his team laboriously reconstructed the straw tatami mats in traditional Japanese homes and even distinguished between the slate-like roofs in Rhenish homes compared with the tiles used in Hamburg; they never bothered to reproduce industrial buildings, suggesting that their targets all along were civilian. Nevertheless, he brags about the "most

67. *Ibid*., 36 and 145.
68. *Ibid*., 5.
69. *Ibid*., 23.
70. *Ibid*., 36.
71. *Ibid*., 50.
72. *Ibid*., 46 and 49.
73. *Ibid*., 76.
74. *Ibid*., 99. Also see 77 and 80.
75. *Ibid*., 81 and 85.
76. *Ibid*., 91.
77. *Ibid*., 198.

impressive . . . performance" of phosphorus gel that when "extinguished with carbon dioxide or water" is capable of reigniting.[78] He brags about the "500-lb 'goop' bomb" and the "Napalm-filled gasoline drums and belly tanks which were used with great success in the Pacific area."[79] The M-69 bomb, he observed, was "used by the millions with devastating effect in Japan."[80] He boasted that many of the bombs carried "a charge of white phosphorus for production of a smoke screen to hamper fire fighting."[81] He was proud of the result, writing that "It is difficult to imagine what happens when 42 lbs. of burning gel is plastered all over the inside of a sturdy wooden barn: flames bursting out of the windows, blasting open the door, belching forth at the eaves and then through the roof. In a matter of minutes what remained of the structure collapsed into a burning heap."[82]

Fieser had also been part of a plan to release thousands of bats carrying napalm-based incendiaries into "highly combustible Japanese houses at sites very favourable for starting fires."[83] After a detailed estimation of the thousands of fires these "bat bombs" would create, he asked "An attractive picture?," replying "All those working on the project thought so."[84] In the end, the project was canceled, although Fieser commented that "the job was done very effectively by M-69s" nonetheless.[85] His life-long pride in inventing the incendiary gel napalm led to him naming one of his beloved Siamese cats "J. G. Pooh," which meant "Jellied Gasoline Pooh."[86] A charming photograph of this cat has pride of place in *The Scientific Method*.

Finally, violence is an essentially contested category in which some acts are included and others excluded. Ideological, political, and economic agents have categorized certain practices as "aggressive" and excluded others. Of course, the distance between ballistics scientists and "violence" did not always go unchallenged. Indeed, at specific periods of history, the "violence" label was thrown at them. As we have seen, Fieser was forced to defend his creation (napalm)—albeit not after the Second World War but during the Vietnam conflict when Nick Ut's 1972 photograph of Kim Phuc brought the horrors of this weapon to the American conscience. Other critics have attempted to destabilize the "dual use" arguments, placing greater emphasis on military medicine than on operational research.[87] Students and faculty have exposed the extent of military funding at their universities.[88]

78. *Ibid*., 36.
79. *Ibid*., 44.
80. *Ibid*., 45.
81. *Ibid*.
82. *Ibid*., 51.
83. *Ibid*., 121.
84. *Ibid*., 134.
85. *Ibid*.
86. *Ibid*., 230.
87. These were terms used by N. M. Rich, E. V. Johnson, and F. C. Diamond, Jr., "Wounding Power of Missiles Used in the Republic of Vietnam," *JAMA* 199 (1967), 157-161, 168, and F. C. Diamond and N. M. Rich, "M-16 Rifle Wounds in Vietnam," *Journal of Trauma* 7 (1967), 619-625. For a response by a ballistics scientist, see Martin L. Fackler, "Wound Ballistics Research of the Past Twenty Years: A Giant Step Backwards," Letterman Army Institute of Research Presidio of San Francisco, Division of Military Trauma Research, Institute Report No. 447 (1990), i and 3-5.
88. For examples from just the US and UK respectively, see Stuart W. Leslie, *The Cold War and American Science: The Military-Industrial-Academic Complex at MIT and Stanford* (New York:

Nevertheless, scientists engaged in war research have been remarkably successful in avoiding connotations of violence. The science of wound ballistics involves researching, designing, and manufacturing weapons aimed at causing the most debilitating wounds in human and nonhuman animals, as well as destroying environments. However, the disconnect between their research activities and the outcomes on the battlefields can be summarized by a comment that prominent weapons designer Harvey made in 1943. He confessed that he "would not be interested in a casualty survey, either at the front or in hospitals in the USA, as this subject would be too distressing for me," adding that "the theoretical aspects of wound ballistics, however, are very interesting."[89]

In stark contrast to those who analyze weapons development as an objective science and who impart violent agency to autonomous technologies, I situate wound ballistics as a branch of applied moral philosophy. Its practice always involves an "ought." Although the central job of ballistics scientists is the "effective production of wounds," this is not regarded as violent, except to their victims, of course. In part, this lacuna is due to an ideological relationship forged between "violence" and *particular* emotional states: anger, for instance. Indeed, one of the main criticisms ballistics scientists expressed about their paymasters (that is, the armed forces) is that the latter were swayed by emotion. In contrast, these scientists orchestrated cool, instrumental violence. Education, gender, class, status, and whiteness were crucial in exempting them from any accusations of being violent men.

At the start of this article, we heard Ridenour warn against "confus[ing] the rather minor matter of weapons design with the basic and tremendous immorality of war."[90] He advised readers to reject war, while continuing to devise its weapons. Fieser, too, had only one word of condemnation for war in his book, where he complained about the extraordinary wastage of "many thousands of dollars" in weapons research programmes that later had to be scrapped. He then admitted that "War is gigantically wasteful, but that is only a minor charge that can be brought against the crime of war."[91] There are good reasons why he never tells readers what the "major charge" might be: it would undermine the entire point of his book, which was to extol both the intellectual and emotional pleasures of *The Scientific Method*.

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Columbia University Press, 1993), and Tim Street with Martha Beale, "Study War No More: Military Involvement in UK Universities" (October 2007), 4, at http://www.studywarnomore.org.uk/documents/studywarnomore.pdf (accessed September 12, 2017).

89. Letter from Harvey to Fulton, October 5, 1943, in the Harvey papers, cited in Lindee, "Experimental Injury," in LaFleur, Böhme, and Shimazono, eds., *Dark Medicine*, 133.

90. Ridenour, "Should the Scientists Resist Military Intrusion?"

91. Fieser, *The Scientific Method*, 158.