Bulletin of the Atomic Scientists

ISSN: 0096-3402 (Print) 1938-3282 (Online) Journal homepage: http://www.tandfonline.com/loi/rbul20

# The psychological power of nuclear weapons

Alex Wellerstein

**To cite this article:** Alex Wellerstein (2016) The psychological power of nuclear weapons, Bulletin of the Atomic Scientists, 72:5, 298-303, DOI: 10.1080/00963402.2016.1216508

**To link to this article:** https://doi.org/10.1080/00963402.2016.1216508

Published online: 08 Aug 2016.

BULLETIN OF THE ATOMIC SCIENTISTS, 2016
VOL. 72, NO. 5, 298–303
http://dx.doi.org/10.1080/00963402.2016.1216508



# The psychological power of nuclear weapons

Alex Wellerstein

**ABSTRACT**

Nuclear weapons and nuclear energy have historically been associated with both apocalyptic fear and salvational hope. Do we fear nuclear technologies too much or too little? The author makes the case that nuclear fear is a double-edged sword: It can be mobilized to reduce risks, but it can also warp risk perceptions. There are countless examples of humans, even experts, miscalculating risks – and any approach that relies on simply "telling people the facts" can lead to public misunderstanding, mistrust, and backlash. On the other hand, gut instinct and human imagination can also lead to poor decisions. Finding new ways to help the public become informed on the relevant issues, without overreliance on imagery of either apocalypse or salvation, should be a major focus of experts with regard to nuclear technology.

**KEYWORDS**

Nuclear fear; nuclear power; nuclear weapons; NUKEMAP; radiophobia; risk perception

Fear sits, uncomfortably and uneasily, at the heart of the nuclear age. It wends its way through our culture, and it is never far away when we get into public discussions of nuclear policy. We have many coping mechanisms: the black humor of *Dr. Strangelove* or singer-songwriter Tom Lehrer on the one hand, the hyper-rationalization and logical systematization of military strategist Herman Kahn on the other. If nuclear fear derives from reason, it comes from the disproportionate amount of power that is released through nuclear reactions. It has historically had a twin emotion, salvational hope (the atom as the savior of humanity), but in recent years this seems to have taken a backseat outside of certain technical and industrial circles.

For nuclear weapons, the fear seems, to some degree, necessary. Its immediate origins are not too surprising: The images of Hiroshima and Nagasaki are persistent, and any technology that makes its world debut by setting aflame tens of thousands of civilians is perhaps appropriately feared. The fear exists for almost all who comment on nuclear weapons. Those who are against the weapons want to end the possibility of further horrors. Those who think the weapons are necessary hope to turn that fear into a tool to modify the world order, to discourage enemies from doing things they would rather they not do.

For nuclear power, the fear is a trickier matter. Nuclear power was initially meant to be the hopeful side of nuclear technology, the "atoms for peace" as opposed to the "atoms for war" that were far more prominent in the 1950s. The fear, there, came in through the back door: the fear of accident and mishap, the risk associated with the unusual contaminating potential of large nuclear reactors, and the special fear of radiation that makes little distinction between weapons and power plants. Those who oppose nuclear power attempt to mobilize and encourage these fears; those who favor it tend to downplay them, to transmute them into technical discussions of risk.

Do we, the people of the present-day world, fear these technologies too much or too little? Ask a dozen experts and you will probably get a dozen different answers. The emotional response to nuclear technology is controversial, because it has stakes. If we fear too much, we act irrationally, perhaps even counter-productively. If we fear too little, we may expose ourselves to unacceptable risks. But who is to say what the right amount of fear is? And is it possible that our nuclear fears are simultaneously both too great and too small, one of the many paradoxes of the nuclear age?

## A history of fear

Several historians have produced works attempting to get a handle on the evolution of human fears and hopes regarding nuclear technology. The most comprehensive in scope, and ambitious in methods and goals, was Spencer R. Weart's *Nuclear Fear: A History of Images*, published in 1988 (Weart 1988), a time of heightened public awareness of nuclear issues in the wake of Ronald Reagan's revival of the Cold War and the accident at Chernobyl. Weart revised the work as *The Rise of Nuclear Fear* in 2012, two decades and a million years

**CONTACT** Alex Wellerstein awellers@stevens.edu

from the late Cold War context of the original volume. Weart's books cover the history of public attitudes toward nuclear technology well, starting with the initial discovery of radiation and the almost immediate association of it with both life-giving and death-causing tropes. He notes early on, for example, that Frederick Soddy's association of radioactive decay with "transmutation," against the objections of Ernest Rutherford that "they'll have our heads off as alchemists," indicated that from the very beginning this new science "could stir strong emotions"(Weart 2012, 3). Soddy was the first great popularizer of the atom, with *The Interpretation of Radium* (1909) providing many of the expansive themes about the socially and historically transformational power of atomic energy that are still familiar more than a century later. Weart continues his books through the historical territory one might expect: the splitting of the atom, the creation of the atomic bombs, the arms races, the accidents, the treaties.

But what makes Weart's book unusually ambitious history is that it does not just confine itself to this chronological approach, one that is by now familiar to most readers of the *Bulletin* and is replicated in the more standard studies of "atomic culture." Weart sticks his neck out a bit further than the typical historian might: into the realm of the psychological and the political. Nuclear imagery, in Weart's view, holds a particularly powerful place in the human psyche because it combines legitimate appeals to unprecedented power with deep-seated human narratives. The trope of both healing and destroying rays is common to many ancient myths, as are invisible plagues and contaminations that hurt not only the living, but also the unborn. And, of course, one need not look far in many belief systems for an apocalyptic end-of-the-world that, with a little bit of theological glossing, can sound plausibly compatible with a full thermonuclear exchange.

If our cultures are well primed to see the bomb in grand narratives, our politicians, journalists, and scientists are often all too ready to weave those narratives explicitly. Weart argues that nuclear imagery is a cultural resource selectively deployed to advance various agendas. No surprise there, but Weart further notes that nuclear imagery is powerful enough to become unhinged from whomever or whatever is trying to deploy it. Want people to be afraid of Soviet nuclear weapons, so that they support the development of American nuclear weapons? Great – except that this same fear can lead to a rejection of other policies, such as civil-defense preparations (dismissed, at times unfairly, by skeptics as pointless in the face of the bomb's power). Want people to understand that fallout is something to be taken seriously, so they will develop fallout shelters? Great – except that fears of radioactive contamination can bleed into the domain of reactor accidents, and now people don't want nuclear power plants sited near them.

Fear, in general, is a double-edged sword: When mobilized, it can be very powerful, but a mob quickly becomes uncontrollable, or transfers control to the unhinged. Nuclear fear, then, might be especially problematic.

An interesting phenomenon is the creation of pseudo-medical terms for those who are designated as overly afraid – rendering some fears psychologically "abnormal" by definition. It is remarkable how not-new this approach is; as early as 1903, a physician at a meeting of the Southern California Electro-Medical Society (devoted to the use of x-rays in medicine) coined the term "radiophobia" to indicate "an undue fear of the x-ray." "To this class," he explained, "belong those who are afraid to make use of the rays or else do not use them sufficiently strong, fearing burns or other untoward results" (Soliand 1903, 360–362). To his credit, he also coined the term "radiomania" for those whose enthusiasm for x-rays was deemed untoward, an unusually symmetrical approach to nuclear fears and hopes from a practitioner. Perhaps this illustrates a point, though: Who would be judged abnormal today for being cautious about x-rays according to the standards of 1903, when an x-ray operator was often identifiable by their scarred and mangled hands?

## Calculating risk

Today, "radiophobia" is deployed somewhat differently. Most precisely, it is applied to those who live in areas of mild contamination as a result of the nuclear accidents at Chernobyl and Fukushima, and is used to emphasize that the fear of radiation can be worse than the radiation itself in such cases (see "The dangers of radiophobia," by David Ropeik, in this issue). The stress caused by thinking that you *are* contaminated can be powerful, whether or not one's health actually is measurably impacted by the radiation in question, and it can cause people to make decisions that might adversely impact their health more than the radiation is likely to. Radiophobia is also applied more broadly to people who fear radiation more than more mundane threats, like driving an automobile. Traffic accidents accounted for roughly 38,000 American deaths in 2015 alone – a significant jump from 2014, incidentally (Ziv 2016). This is on the order of the total radiation-related deaths that Richard Garwin (2006) has estimated as likely occurring as a result of the Chernobyl accident: 34,200. Anyone who fears Chernobyl more than automobile deaths likely has their priorities wrong, in this estimation. (Much less the biggest killers of Americans: heart disease, lung cancers from smoking, and so on.)

What is tricky, here, is that while there are certainly those whose fears of radiation and nuclear technology go vastly beyond the actual threats posed by them, pinpointing exactly when those fears reach into psychologically "abnormal" territory seems inherently fraught, and in many cases there is no easy "objective" measure of how worried one ought to be. The raw numbers used to estimate risk are hard to intuitively grasp: If you are 75 times more likely to be killed by lightning than by a shark attack in the United States (Florida Museum of Natural History Undated), does this give you a clear guideline to rational behavior? Does it mean you should spend less time worrying about sharks, or more time worrying about lightning? How do you know if you're spending too little or too much on either? And how much do local parameters matter? Presumably some activities could raise one's risks of a shark attack, for example, but someone who never swims in the ocean need not fear sharks at all.

When risks taken by individuals only affect those individuals, the rest of us tend to give them a pass if we feel the decision to take on the risk is voluntary: If you want to climb mountains without a harness, it's your funeral if that goes wrong. When the consequences spread to many other individuals, we start to worry a bit more, and regulation often steps in (automobile driving is regulated not because of the individual risk to the bad driver, but because the bad driver puts other drivers at risk). Nuclear technology pushes this risk calculation to its extremes. Its entire appeal, both for power and for weapons, is that you can rely on exponential reactions to scale up energy levels very rapidly. The downside of this is that the amount of risk tends to scale as well. There are few situations in which a non-nuclear power plant can acutely endanger as many people or property values as a large nuclear reactor can. (Some dams fall into this category, but nothing else does.) There are few weapons that can take as many lives as easily and quickly as a nuclear bomb. (Some other weapons of mass destruction might fall into this category, but no conventional weapons allow that kind of instant power magnification.)

The risk of a nuclear power plant malfunctioning catastrophically is pretty low. Since the early 1950s there have been nearly 600 nuclear reactors used for electricity generation globally, over the course of some 65 years. Of these, there have only been two "major accidents" (level 7), according to the International Nuclear Event Scale: Chernobyl in 1986 and Fukushima in 2011. There have been several lower-level accidents at nuclear power facilities (Three Mile Island is ranked as an "accident with wider consequences," level 5), but most of the other higher-ranked accidents were not at power plants or civilian reactors. On the face of it, that's not a terrible record: two major accidents, both due in part to extraordinary circumstances (poor design and operational errors at Chernobyl, the earthquake and subsequent tsunami at Fukushima). But the consequences of each of these large accidents have been substantial. The Chernobyl accident has resulted in hundreds of billions of dollars' worth of economic damage for cleanup, remediation, and lost opportunities in the regions affected. The human cost has been controversial to calculate: It depends, in part, on what assumptions one makes about the effects of low levels of radiation. Using the figures in the National Academy of Science's BEIR VII report (Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation 2006), one would expect something like 20,000–35,000 excess fatal cancers to have resulted in the exposed populations.

This is not an apocalyptic number: It is a small fraction of the total fatal cancers that the same population would suffer from other causes during that same period (Garwin 2006), so small that teasing these excesses out of the total epidemiological cancer "noise" is quite difficult (and controversial). But these are still high enough numbers to take seriously. Also, the fact that an accident like Chernobyl unfolds in one event – as opposed to lots of smaller, individual events – affects our risk perceptions. Most people rightly consider their odds of dying as a result of a commercial airplane crash to be low, but during the same period of time that civilian nuclear power has been around, some 73,000 people have died in airplane crashes (Aviation Safety Network 2012). And despite the aforementioned tens of thousands of people who die in automobile accidents in the United States each year, most people are extremely cavalier about the risks of driving.

Trickier yet in making sense of low-probability, high-risk accidents is the fact that they are not a zero-sum game. If the power that was being generated by reactors at Chernobyl or Fukushima was replaced by, say, the equivalent number of fossil fuel plants, what would the harm be to both local and global populations in terms of emissions and climate change? This sort of argument is common among those pushing for nuclear energy, in part, as an answer to the threat of carbon emissions – that in a realistic world picture (which is to say, one that discounts other low-carbon energy technologies as being currently unable to scale to the levels required by societies), the net risks are still lower with nuclear than other technologies.

## The limitations of statistical approaches

That people judge nuclear risks higher than other, more mundane, daily risks is not a new observation. It is easy, and something of a cop-out, to simply say that people's risk perceptions are "wrong." Yes, people worry more about low-probability events than they probably should. We should all spend more time worrying about the fact that our lifestyles (in the United States, anyway) are more likely to kill us than anything else. But if we only use a measure of what happened in the past as a measure of what will happen in the future, we run into the 18th-century philosopher David Hume's classic "problem of induction": Past events do not necessarily determine future outcomes, because we cannot be sure the outcomes are indicative of the underlying causalities. (The classic example: A chicken concludes that the benevolent farmer will feed him every day, because that is what has always happened as long as the chicken has been making observations. One day, the farmer instead cuts his head off. The chicken did not understand that he was on a farm and what that meant for his mortal situation – he was missing a key truth about the world, and if he had known it, he would have more properly understood the risks he faced.)

To put it another way, under a truly inductive approach, we ought not worry about a nuclear exchange, because it hasn't happened. The paucity of this approach is rather obvious: Just because it hasn't happened, doesn't mean it can't happen, and more to the point, the worrying about it in many cases played a demonstrable role in preventing it from happening: If Kennedy and Khrushchev had not worried about nuclear war in 1962, where would we be today?

Which is just to say: Statistical approaches can give people some information about how we ought to evaluate low-probability, high-consequence technologies, but at some level we also have to rely on our imaginations about what the future might hold. And from our imaginations come our fears and our hopes, which in the case of nuclear technologies tend to come in extremes.

## An alternative approach to "the facts"

What's the way out of this bind? I see no simple answer. There are those who think we can easily quantify the risks, and make simple decisions based on that. I am less optimistic, in part because, as a historian, I am exposed to countless examples of people (including very intelligent, very informed experts) misjudging risks greatly – especially complex risks that require many human systems to operate together. Humans are fallible, our systems are fallible, and consequently our risks will probably be larger than we calculate them to be: a rather elaborate version of Murphy's Law.[1]

At the same time, I am also naturally wary of relying merely on public perception, gut instinct, and worst- or best-case-scenario reasoning for finding the proper path forward. Publics make poor decisions all the time, and if these matters are notoriously thorny even for experts, they are doubly so for people whose exposure to statistical thinking, the details of radiation and nuclear reactions, and so on are comparatively minimal. To dismiss publics is clearly not the right answer: Technocracy leads to distrust and backlash, and that doesn't help anything. But any approach that relies on simply "telling people the facts" is missing out on a lot of sociological research indicating that facts alone do not determine public positions on anything.

Do we fear the atom too much, too little, or just enough? My perception is "all of the above." It is easy to find times in the past when people's fears seemed too low, and then swung to being too high: Americans were a bit too blasé about the bomb in the late 1940s, and then swung the other way a bit too hard in the 1950s. There is a strand of nuclear history that seeks to show the fears of the past as being overwrought and potentially humorous in retrospect. (There is a bit too much of a mocking sneer in the well-known 1982 film *The Atomic Cafe* for my taste.) There are also attempts to mobilize fear that have been potentially counterproductive – the campaigns against civil defense training in the United States, for example, seem to be partially responsible for a generation of people who give little thought to the bomb. (If children still had to practice taking cover under their desks, that would leave an impression about the likelihood of nuclear war.)

I have tried to develop an alternative approach in my online NUKEMAP nuclear weapons effects simulator tool: It attempts to give fairly straightforward and plain technical information in a format that laymen, journalists, students, and experts alike can find intuitively understandable. It allows for the user to "experiment" with different possibilities, as a means of calibrating their own understanding of technical information, delivered in a non-didactic manner. NUKEMAP does not try to tackle the full question of risk, of course: It only conveys information about what nuclear weapons are capable of doing, should they go off.

When launched, NUKEMAP presents the user with the familiar Google Maps interface. If the web browser can detect the user's location, the default city shown is the nearest large city to the user (the idea being that everyone has been to "the big city nearby" even if they aren't living in it). The user is then asked what nuclear weapon they would like to see virtually "detonated" in that city. A variety of preset options are offered: historical nuclear weapons (for example, the weapons used on Hiroshima and Nagasaki), present-day nuclear weapons (such as the warheads used in Trident D5 missiles), and weapons of a variety of sizes from the sub-kiloton "Davy Crockett" tactical warhead up to the 100-megaton "Tsar Bomba" of the Soviet Union. Once a weapon is chosen, the bomb is "detonated" and the results are displayed in multiple ways: Circles on the map show the range of various effects (blast, heat, ionizing radiation) from the designated Ground Zero, while quantitative and qualitative explanations of these ranges and effects are presented on the side of the screen. Local fallout (if any) can be graphed in familiar plumes, and a rough estimate of fatalities and injuries is calculated using local population densities. Changing the settings and rerunning the simulation is just a matter of clicking buttons – the results are easy to modify and change.

The NUKEMAP concept is somewhere between "active learning" (in which "students" are in charge of their own education) and "gamification" (in which education is rendered into "games"). It is not quite a game, and not quite a lecture. Its flexibility makes it useful for a wide range of audiences. College professors lecturing on Cold War history, high school students writing reports on modern nuclear risks, and journalists writing about historical accidents have all made extensive use of NUKEMAP in their work, to give just a few examples. There are, on any given day, about 10,000 people using the website, with traffic peaks coinciding with major world events (for instance, North Korea testing another nuclear weapon) and major anniversaries (such as the 70th anniversary of the Hiroshima attack, when hundreds of thousands of people mapped the effects of the Hiroshima bomb on their own cities). NUKEMAP is frequently shared and discussed on Twitter, Reddit, and Facebook, among other social media and news websites. Its visual, interactive, massively distributed, and sharable nature makes it ideally suited to the millennial generation, and I am often amused to see how it is deployed to settle online arguments.

The response has been encouraging: Millions have used it for a variety of purposes, and the general sentiment of the feedback I receive (or view on social media) is that people are surprised by both what nuclear explosions can and can't do.[2] They don't destroy the world in one big flash, but they are capable of a level of destruction that is unprecedented in our day-to-day lives. This is not a paradox: The nuclear-weapons risk is not "business as usual," but it is also not something that is impossible to imagine. It takes place at a large scale, but not necessarily an inconceivable scale.

Perhaps this is a model for moving forward: Experts need to find more ways to help people better wrap their heads around the magnitudes of nuclear risks and benefits, and to see nuclear technologies as existing in a space somewhere between the extreme boundaries of apocalyptic and salvational. Finding new ways to allow the public – and, crucially, the journalists and other gatekeepers whose own knowledge leads to the framing of discussions and debates – to intuitively calibrate their understanding of "what could go wrong," using flexible-but-straightforward digital simulations, may be an important new tool for the public understanding of complex technologies.

## Notes

1. On nonlinear, complex technologies risks of this sort, the classic sociological text is Perrow (1999).
2. For a preliminary analysis of NUKEMAP user trends, see http://wmdjunction.com/120503_nukemap_educational_tool.htm; a more comprehensive study, with a larger and more fine-grained approach to the data, is in the works.

## Disclosure statement

No potential conflict of interest was reported by the author.

## Notes on contributor

*Alex Wellerstein* is an assistant professor at the Stevens Institute of Technology in Hoboken, New Jersey. He writes Restricted Data: The Nuclear Secrecy Blog (http://blog.nuclearsecrecy.com) and is the creator of the NUKEMAP online nuclear weapons effects simulator (http://nuclearsecrecy.com/nukemap/).

## References

Aviation Safety Network. 2012. "Fatal Airliner (14+ Passengers) Hull-Loss Accidents." *Flight Safety Foundation*, December 21. https://aviation-safety.net/statistics/period/stats.php?cat=A1.

Committee to Assess the Health Risks from Exposure to Low Levels of Ionizing Radiation. 2006. *Health Risks from Exposure to Low Levels of Ionizing Radiation, BEIR VII Phase 2*. National Research Council of the National Academies. Washington, DC: National Academies Press. www.nap.edu/catalog/11340/health-risks-from-exposure-to-low-levels-of-ionizingradiation

Florida Museum of Natural History. Undated. "Shark Attack Compared to Other Risks." *International Shark Attack File*.

https://www.flmnh.ufl.edu/fish/isaf/what-are-odds/risks-comparison/.

Garwin, R. L. 2006. "Outside View: Chernobyl's Real Toll." *UPI*, April 20. http://www.upi.com/Business_News/Security-Industry/2006/04/20/Outside-View-Chernobyls-real-toll/72371145562307/.

Perrow, C. 1999. *Normal Accidents: Living with High-Risk Technologies*. Princeton: Princeton University Press.

Soddy, F. 1909. *The Interpretation of Radium*. New York: G. P. Putnam's Sons.

Soliand, A. 1903. "Radiophobia and Radiomania." *American Electro-Therapeutic and X-Ray Era* 3 (10, October): 360–362.

Weart, S. R. 1988. *Nuclear Fear: A History of Images*. Cambridge, MA: Harvard University Press.

Weart, S. R. 2012. *The Rise of Nuclear Fear*. Cambridge, MA: Harvard University Press.

Ziv, S. 2016. "2015 Brought Biggest Percent Increase in U.S. Traffic Deaths in 50 Years." *Newsweek*, February 17. http://www.newsweek.com/2015-brought-biggest-us-traffic-death-increase-50-years-427759.