KNOWN UNKNOWNS:
The Psychological Impacts of a Nuclear Battlefield

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The past century has seen impactful evolutions in the technology of warfare. Multiple nations developing nuclear weapons (NWs) are potent examples. Russia and China's efforts on this front have complicated the United States Army's mission of maintaining readiness for Great Power Competition. This challenge is not lost on the Army, as evidenced by Research and Development and Operations and Maintenance activity: modeling fallout, developing radiation protection, and anticipating NWs in combat.[1] However, the question of individual readiness for a nuclear attack is not simply a technological one. Despite the continuing evolution in military technology, the *people* who fight wars remain salient. Victory and defeat alike are products of our actions just as much as the technology we employ. So, we must account for the psychological effects NWs have on warfighters, despite our inability to model them as precisely as traditional NW effects. This project begins that task by considering case studies and psychological literature that may be analogous to the nuclear battlefield. The behavioral patterns drawn from there form the beginnings of our realizing the known unknown psychological impacts of NWs. Accounting for those can begin a new discussion: is our force ready?

Soldiers far enough from the blast to avoid expected weapon effects will suffer purely psychological effects caused by their ignorance toward NW effects. Soldiers close enough to receive direct weapon effects will be susceptible to psychic numbing, a condition characterized by decreased energy and attentiveness. Both states may be significant enough to pose challenges to warfighting capabilities. For both cases, we suggest increasing awareness of NW effects and training with relevant equipment so Soldiers can protect themselves as best as possible.

Clarifying Scope and Diction

As the title implies, this project attempts to address how a nuclear attack will alter behavior. Though bodily effects of NWs like burns and blindness are technically "behavioral responses" as much as feelings of pain, confusion, and fear are,[2] many works have examined those effects (expected NW effects). Fewer have regarding their psychological implications.[3] Our motivating assumption is that people's actions can be altered without an easily detectable cause. Soldiers are not immune to the indirect effects of warfare. Like most people, American troops have preconceived and often fallacious notions of NWs from their portrayal in media, and little is done to change these once Soldiers are in the Army. How Soldiers will react if an adversary uses a NW is not immediately evident. These are the known unknowns.

This project addresses two categories of psychological effects on combatants: proximal and distal, referenced in the second paragraph briefly. What differentiates them is the distance from the blast.

Proximal effects exist solely for those close enough to receive physical weapon effects like burns and radiation. Because expected NW effects are present, proximal effects are plausibly caused by a combination of physiological and psychological phenomena. That is, both bodily and psychological trauma received close to a nuclear detonation cause proximal effects. Distal effects will be present in units far enough from the blast to be safe from expected effects. Because expected effects are absent here, distal effects are causally only due

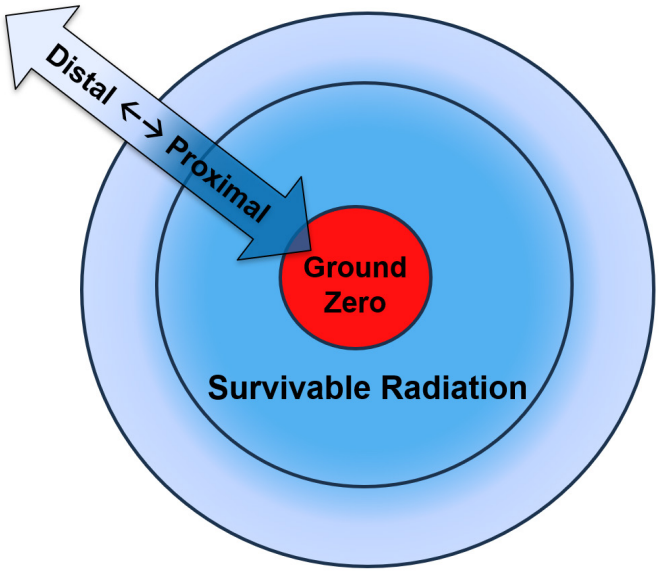

FIGURE 1. Simple depiction of the proximity-based psychological threat model (Author produced graphic)

to psychological phenomena. Overlap is expected. A unit's location could span many distances. However, separating the two is the simplest way to understand the proposed effects.

Psychic numbing – a response to extreme trauma – will be referenced frequently while discussing proximal effects later. Though the term can have other connotations, we mean decreased attentiveness, emotional affect, motivation, and curiosity.[4] The condition is often linked to post-traumatic stress disorder.

The term *psychosocial* will appear when discussing proximal effects. Psychosocial simply connotes an interplay between social factors like roles and responsibilities and individual behavior. A psychosocial effect thus implies social effects, in addition to individual.

Distal Effects: Purely Psychological Casualties

Our evidence for distal effects is drawn from three case studies. The first and last are of populations interacting with chemical, biological, radiological, and nuclear (CBRN) threats at removed distances. For most people, chemical, biological, and radiological threats share a comparable novelty with nuclear threats. In CBRN incidents, it is not always clear when one is affected. The second case study contrasts WWII London's psychological reaction to The Blitz with the V-Weapon bombings later in the war. These examples make clear the high probability that Soldiers under attack from NWs will suffer purely psychological casualties. Those being casualties caused not by physical harm, but by worry and ignorance alone, often referred to as psychosomatic responses. This project labels such effects "distal" because they apply to units far enough from the blast to avoid expected weapon effects but close enough to incorrectly think they are irradiated .

Gas Warfare in World War I

We see parallels between the nuclear battlefield and the first uses of chemical warfare in WWI. Like our modern force's relationship with NWs, most Soldiers 120 years ago were unaware of gas's effects, and troops had yet to encounter it in combat. Opportunities for familiarization beforehand were substantially lacking.

For each Soldier who required evacuation to a field hospital because of actual gas exposure, two more were evacuated who only *believed* they were gassed.[5] That means two-thirds of gas-related "casualties" suffered from purely imagined gas exposure. To understand why that was, let us look at accounts from Soldiers and consider their thought processes:

> "I witnessed from the air the first [chlorine] gas attack in the Ypres Salient. Suddenly we saw to the north of us […] this yellow wall moving quite slowly towards our lines. We hadn't any idea what it was" – Archibald James, an observer in the Royal Flying Corps.[6]

Though Soldiers were initially unsure of this new threat's nature, its consequences were soon made clear:

> "When the gas attack was over and the all clear sounded I decided to go out... [to] see what was happening. But I could hardly believe my eyes... The bank was absolutely covered with bodies of gassed men. Must have been over 1,000 of them" – Lendon Payne, British Sapper describing the Second Battle of Ypres.[7]

Contrast novel CBRN threats with gunfights, where the threat is clear and universally understood. Warfighters usually can tell when someone has been shot, especially the victim. With CBRN weaponry, the situation is more muddled. Soldiers in WWI had yet to become familiar with gas. A review found that in all five examples of widespread gas panic in WWI, "the attacked troops had poor […] training […] in using the gas mask […] or none at all"; in one of the five cases "the men

ABOVE: Men of the 2nd Argyll and Sutherland Highlanders wearing cotton-waste pad-respirators, 1915 (Imperial War Museums)

had no gas masks at all.[8] Many Soldiers suffered imagined effects as a defense mechanism. Psychosomatic response in such a setting is highly adaptive, given how uncertain the threat of exposure seems, and how risk-averse evolutionary processes have made us.[9] When presented with novel threats, the norm is to overreact as a defense mechanism. And in the case of gas warfare, no Soldiers were veterans, no one understood the scope of the threat, and too many had no idea how to use their safety equipment. The Soldiers who *believed* they were exposed unknowingly mimicked symptoms of exposure to receive medical attention. One can imagine how similar casualties may arise in the nuclear context. In that case, too, everyone will be inexperienced when the first bomb drops. Gas warfare early in WWI exposes the importance of training with equipment and understanding the nature of new and novel threats on the battlefield.

V-Weapons in World War II London

Most are familiar with the Blitz: the German bombing of the United Kingdom in WWII from 1940-1941. Fewer are aware that bombing returned later in the war. Soon after the Allies landed at Normandy, Germans began launching V-weapons at London (among other targets).[10] Relative to human and infrastructural damage, the V-weapon attacks on London produced disproportionately more psychological harm than the Blitz. Knowing why that was contributes to our understanding of NW's distal effects and how to combat them. First, evidence that V-weapons produced more psychological harm, despite the Blitz destroying more life and infrastructure, will be presented. Then, we will offer a psychological explanation.

The Imperial War Museums put it simply: "The destruction wrought by the V-weapons was less than that endured during The Blitz of 1940-1941."[11] The Blitz killed 20,000 and injured 25,000.[12] Approximately 2,500 V- weapons landed within the London region, killing 4,840, and injuring 24,500.[13, 14] During the Blitz, one of every six Londoners was homeless at some

point, and at least 1.1 million houses and flats were damaged or destroyed.[15] Estimates of houses affected by V-weapons in London vary, but estimates group generally fall in the hundreds of thousands.[16] Despite the larger scale of destruction, Londoners maintained healthier mindsets during the Blitz. The phrase "Business as usual" frequently appeared on boarded-up shop windows.[17] The city reacted differently later in the war – when V-weapons caused more "psychological stress."[18]

In 1971, Jay Weiss found that our ability to cope with pain increases significantly when we can anticipate its coming.[19] In a famous study, one group of rats was administered electric shocks in such a way that they could foresee the impending pain. This group adapted to the stimuli. Another group was shocked randomly, eventually growing ill and weak.

The two groups of rats are analogous to Londoners at both parts of the war. During the Blitz, sirens sounded before the bombs dropped, giving people time to prepare. Londoners had been preparing for air raids for more than two years.[20] Knowing attacks were imminent and taking action boosted morale:

> "The speed with which people in a dazed and bewildered condition could be organized […] determined the rate at which damage could be repaired, production returned to full capacity, and further demoralization in surrounding areas avoided. What was needed, the observers of that time agreed, was a 'much more powerful and imaginative organization' to deal with 'the purely psychological and social effects of violent air attack' [mass observation from 1940]."[21]

The Blitz was set up with a "long conditioning period… [which] served to give the population time to develop coping responses."[22] Contrast these observations with those of Londoners later in the war, who found "V-weapons apparently random strikes […] unnerving."[23]

Comparing the psychological effects of V-weapons to the Blitz in London yields clear takeaways for the nuclear battlefield. First, we might mitigate proximal effects by emphasizing early warning/detection. When encountering NWs is possible, equipping and training units with radiation measurement devices like AN/UDR-13s is a clear step toward boosting detection abilities. Once detected, streamlined communication up and down the chain of command would provide Soldiers with opportunities to employ coping responses. Doing so would boost mental assuredness and lower stress. The advent of V-weapons is analogous to a later development that works against Soldiers in the nuclear context: the proliferation of new NW delivery devices. Adversaries now possess a plethora of ways to employ NWs. These challenges create more ways to surprise Soldiers with a nuclear threat. Educating Soldiers on plausible ways they could encounter NWs is of clear use as well.

Radioactive Material in Goiânia

A famous civilian radioactive materials incident occurred in Goiânia, Brazil in 1987. Like our case studies from World War I and II, the inhabitants of Goniania suffered psychosomatic, imagined effects. Their situation shows on a massive scale how easily people misrepresent contamination in CBRN cases. Though only 250 people were legitimately exposed to the radioactive source, more than 110,000 sought treatments for it.[24, 25] It is unclear to what extent if any the Goiânianese people's stress caused physical symptoms to develop. As sources do not mention any, they likely did not suffer physically to the same extent Londoners did because of V-weapons, and even less likely as much as Soldiers in our WWI case study, who required hospitalization. However, some of the 250 who were irradiated sought treatment for "Tropical Diseases" instead of irradiation, highlighting the general confusion surrounding CBRN incidents with unfamiliar populations.[26] This final case is another that displays the prime cause of psychosomatic responses in CBRN incidents: novelty and unfamiliarity of the threat. It is easy to imagine NWs causing similar reactions in Soldiers if they are left unsure of their level of contamination.

Distal Effects: Takeaways

Anticipating the uncertainty produced by the novel nature of a nuclear attack sets up the discussion of force readiness implications and takeaways. Regarding gas attacks in WWI, the overwhelming presence of psychosomatic responses makes sense, given the Soldiers' lack of training and familiarization with their masks and the unprecedented nature of gas as a weapon. Londoners in WWII were able to develop coping responses and organize as a city preparing for the Blitz, while V-weapons were harder to anticipate. In Goiânia, civilians had no ability to detect radiation and were generally unsure of what, if anything, was wrong with them.

All three case studies indicate that novelty and unfamiliarity are the prime causes of psychological impacts in CBRN incidents. So, training must focus on instilling knowledge of NW effects and familiarization with equipment to minimize negative psychological responses. Before their first encounter with one, Soldiers must understand their effects, be able

to independently determine their level of irradiation, and be aware of preventative measures. Implementing even a basic understanding will allow Soldiers to create coping responses and be more lethal on the nuclear battlefield.

Proximal Effects: Depressed Motivation and Psychic Numbing

We first proposed that psychosomatic casualties should be expected in units removed from a NW's expected effects. What about units close enough to suffer these effects? The terrible environment expected close to a nuclear explosion would likely induce psychic numbing in adjacent units. Overcoming the psychosocial implications of these effects will require deliberate, focused preparations for fighting on the nuclear battlefield.

Two case studies are considered here. The first is 9/11 first responders. The second is Hiroshima and Nagasaki. Both are considered relevant for having characteristics that seem analogous to those close to a NW's detonation. We will then speculate about brain irradiation as an exacerbating stimulus of psychic numbing.

First Responders at 9/11

First responders' psychological reaction to 9/11 is relevant to understanding that of combatants in nuclear war. Like a NW in combat, the attack was novel and highly unprecedented, and first responders had not trained for such a situation. Further, like Soldiers in combat, they had a mission to accomplish that was complicated by the environment they had to operate in. Unlike Japanese civilians in our next case study, their behavior was not oriented exclusively toward survival. They had to save lives and work through the horrific circumstances around them.

Three relevant findings exist. Only two weeks after the towers fell, first responders met the threshold for post-traumatic stress disorder (PSTD), six times as often as members of the general population.[27, 28] From this discrepancy, we infer that Soldiers might incur trauma at a greater rate than if they were only concerned with fleeing a NW, like nearby non-combatants. Proximity to the towers was positively related to rates of PTSD.[29, 30] This will likely apply to the nuclear context too, as trauma-inducing incidents are likely to occur proximally, where harmful effects are more prevalent. Finally, in addition to witnessing PSTD-inducing events, personal injury was also positively correlated with PTSD symptoms.[31] This adds to the likelihood that PTSD-like symptoms will occur proximally in nuclear combat, as horror and injury will be abundant. These symptoms may develop at an alarming rate and affect combat readiness before Soldiers are able to seek out necessary mental health resources.

Memories of Hiroshima and Nagasaki

The horrific records from those who survived the attacks in Japan reveal behavioral effects that, if present in Soldiers, will affect combat readiness. In the immediate aftermath of the bombings, one diary remembers victims as "(moving) and (behaving) like automatons."[32] Another more formal source categorizes them as "fatigued," "mentally weak," and "closed off."[33] Robert Lifton coined the term psychic numbing while studying victims in Hiroshima to capture these descriptions in one term.[34] Their psychic numbing and "closing off" make sense, functioning as "defense mechanisms" against the incomprehensible stress their bodies received in such short amounts of time.[35] In the context of ground combat, awareness of and preparation for these threats is needed and could make an incredible difference.

It may be that psychic numbing as a condition increases obedience. In 1989, Andrew Mickley claimed that in Hiroshima numbing led people to be "most likely to pursue the goals established by others."[36] Citing a victim:

> "All the people were going in that direction […] so I suppose I was taken […] and went with them […] I couldn't make any clear decision in any specific way […] so I followed the other people […] I lost myself and was carried away."[37]

Psychosocial implications for a ground unit on the nuclear battlefield are clear. Soldiers will be disengaged and less autonomous, making decentralized command and autonomy tough to employ. Decision-makers must understand the increased importance their commands will have for their subordinates. It may be that more centralized command structures could protect tactical units from psychic numbing leading Soldiers astray on the nuclear battlefield.

In training, small unit leaders must be made aware of the increased importance of their example and directions due to psychic numbing. On the nuclear battlefield, "*Leadership*… the activity of influencing people by providing purpose, direction, and motivation to accomplish the mission" will be more challenging.[38] If a more centralized command structure mitigates psychic numbing's effects, it could justify changing how we fight doctrinally, in a nuclear context.

ABOVE: September 16, 2001, NYFD searching for survivors among the wreckage (Andrea Booher/FEMA)

Possible Neurological Underpinnings for Psychic Numbing

The combined effects of NWs are brutal and damage the mind and body in many ways. Seeing peers and one's surroundings suffer the hellish conditions near a blast will also harm Soldier's psyche. Though we cannot be certain of the extent each effect contributes to psychic numbing, radiation may play a nontrivial role. That is, irradiation may exacerbate psychological harm associated with the nuclear battlefield, specifically psychic numbing. Here we present animal research showing irradiation depresses individual motivation and curiosity in ways reminiscent of the discussed observations from Japan. Radiation's ability to cause neurological damage is "well accepted" at doses "greater than 15 Gy," and "increasing evidence supports radiation-induced brain injury at lower doses."[39] The question then is what are the behavioral effects, and how sure can we be that irradiation plays a causal role?

Behavioral changes seen in primates and mice mirror the discussed changes witnessed at Hiroshima and Nagasaki – where the term psychic numbing was applied. Though some knowledge about specific neurological effects exists,[40] useful takeaways seem too difficult to infer, currently. Some behavioral implications can be generalized, though. Experiments on primates have demonstrated that irradiation suppresses curiosity and attentive behavior.[41, 42] Another found that tasks requiring attention to stimuli in monkeys' periphery suffered from radiation.[43] "Subdued behaviors" have been assessed as "prominent" in irradiated primates, "perhaps mediated in part by some radiogenic Central Nervous System effects."[44] The most powerful data point is from a study done to determine neurotic reactions to the atomic bombings in Japan. Of 7,297 irradiated patients, 533 (7.3%) experienced neurosis-like symptoms; these symptoms were twice as common in patients who also had radiation illness than those who did not.[45] This suggests that radiation may be significantly harmful to psychological well-being, even when accompanied by expected NW effects.

These findings support the possibility that NW's radiation could exacerbate traumatic psychological effects and suppress healthy functioning, though the prime cause of trauma and suppressed functioning likely remains traditional weapon effects.

Proximal Effects: Takeaways

Regardless of the primary cause, psychic numbing is expected in Soldiers facing NWs, as are PTSD-like symptoms. Possible countermeasures for the former could include command centralization: both emphasizing task prioritization and simplifying courses of action. For the latter, behavioral health resources should be ready once Soldiers can be taken off the line.

9/11 first responders' dramatically higher rates of PTSD seem fair to extrapolate to the nuclear context, given the parallels. Trauma and horror seen in nuclear combat will likely cause high rates of stress-related symptoms in Soldiers. The use of NWs in Hiroshima and Nagasaki makes the likelihood that psychic numbing symptoms exist for Soldiers in nuclear combat high, too. Though speculative, experiments on primates and rats and records from Japan suggest that radiation could exacerbate the symptoms of psychic numbing recorded in Hiroshima and Nagasaki.

Conclusions and Looking Forward

Beyond the understood physiological effects, it is clear a nuclear attack will have negative psychological effects on warfighters, though their precise nature is unknown. Distally, our general ignorance of NWs' effects is likely to cause psychosomatic responses. Soldiers far enough to avoid expected weapon effects directly may still be close and poorly trained enough to think they have. It is also worth considering how distal effects might arise in civilian populations. Imagine a scenario in which we employ a tactical NW far enough from a town for the locals to be safe, but close enough for them to see and/or know about the blast. Noncombatants might think they will be irradiated – creating a new set of challenges for damage assessment. Proximally, the hellish conditions closer to the blast will damage Soldiers' bodies and put unfathomable stress on their minds. Psychosocial effects will inhibit Soldiers' focus due to psychic numbing.

Increasing soldiers' training with dose measurement devices like the AN/UDR-13 and familiarization with dose rate effects are two great examples of actions that put control in the force's hands and remove uncertainty. Perceived novelty can also be lowered by exposing units at the National Training Center and the Joint Readiness Training Center to simulated nuclear threats. This would allow them to mitigate surprise and decrease the novel nature of an otherwise never-before-seen threat. Exposure to tools like Mission Impacts of Nuclear Events Software (MINES) and education about NW effects would help too. People frequently overestimate the scope of NW's danger, despite their wild variance in yield and effect radius.

"The degree to which one anticipates a disaster has important bearing upon the way in which one responds…"[46] In his interviews with survivors from Hiroshima, the "predominant tone" Robert Lifton heard was "extreme surprise and unpreparedness."[47] The Army cannot replicate their misfortune; we cannot fail to anticipate NWs in combat. Nor can it fail to adapt doctrinally and prepare Soldiers for their effects.

Future work could examine more case studies that may be analogous to the nuclear context, distally and proximally. Other CBRN incidents and studies done on Soldiers in combat could be considered, as they are the most likely to be similar. Live trainings done with NWs in Nevada during the 20th century are of particular interest. The proposed neurological underpinnings of psychic numbing as it relates to irradiation could be investigated, too.

Psychic numbing and PTSD-like symptoms should be expected in soldiers facing NWs. Possible countermeasures for the former could include emphasizing task prioritization, simplifying courses of action, and centralizing command structures. Training for the nuclear battlefield will allow Soldiers to build muscle memory, which would be useful for combatting psychic numbing's effects on combat readiness. As for PTSD, behavioral health resources should be available, and Soldiers should be aware of its likelihood.

"Are we developing the warrior that the modern battlefield requires?"[48] Army leadership has been and will remain fixated on this question. Our guard can never go down. To be ready for today's battlefield, we must anticipate its having NWs – for the good of our fighting force and of our nation. ■

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