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Marshall D. Foster
Unite States Air Force Academy, marshall.d.foster@edu.edu

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Cadet Voice
Artificial Intelligence and Stability in Nuclear Crises

Marshall D. Foster

The following USAFA cadet independent study, with the exception of minor grammatical corrections, is produced as presented at the winter conference of the Project on Nuclear Issues (PONI), Center for Strategic and International Studies, Washington, D.C., Dec. 11, 2019 (https://www.csis.org/events/poni-2019-winter-conference).

Technological advances in artificial intelligence (AI) by the United States, China and Russia jeopardize the longstanding nuclear peace that the world has enjoyed since the end of the Cold War.[1] The desire to obtain AI capabilities for the purpose of strengthening defense and security postures could spur a new arms race among these powerful nuclear states, and the United States, China, and Russia have all expressed their interest in extensive AI research and in the implementation of AI in their nuclear operations. The application of AI in the nuclear operations of a superpower risks undermining the world's relatively stable nuclear infrastructure, as AI could essentially make a nuclear war "winnable" for the power that can harness its benefits first. Furthermore, and perhaps more importantly, the likely asymmetric acquisition of AI-enhanced technology will introduce a new degree of uncertainty as these great-power states incorporate it into their nuclear systems. As this uncertainty escalates, nuclear crisis stability may experience severe adverse effects, increasing the chances of a hostile nuclear strike.

This study examines the probable impacts of the asymmetric acquisition of AI-capabilities on nuclear crises stability by defining relevant terms, reviewing relevant existing literature and relevant historical cases, forecasting how asymmetry will affect stability, and formulating a methodology to predict how asymmetry may arise in the future.

Ultimately, it concludes that the likely forthcoming asymmetry will decrease nuclear crisis stability. In response, the United States and the international community should engage in methods to limit the likelihood of great-power states seizing advantages that AI may provide for their nuclear capabilities. These methods include pushing for transparency, intelligence gathering, and arms control.

LITERATURE REVIEW AND RELEVANT DEFINITIONS

Future Impacts of AI

Michael Horowitz's analysis of possible first-mover advantages following AI development has set the stage for research in this field. Horowitz aims to answer the question, "What will advances in artificial intelligence mean for international competition and the balance of power?" (Horowitz, 2018: 37). He evaluates how

[1] Second Lieutenant Marshall Foster (USAFA '20) is pursuing his master's degree at Georgetown University, Washington, D.C.

developing AI capabilities will influence military power and international relations while stressing that AI is more than a technology within itself. Rather, AI is an enabler like electricity or a combustion engine. Answering his original question, Horowitz provides two possible answers.

First, "key drivers of AI development in the private sector could cause the rapid diffusion of military applications of AI, limiting first-mover advantages for innovators" (Ibid.: 37). On the other hand, Horowitz recognizes that the application of AI to military uses may be more difficult than many expect and therefore may provide substantial first-mover advantages for global powers. When comparing these two possibilities, he asserts that diffusion of AI would lower the likelihood of a first-mover advantage, but military AI may be more "excludable" than civilian uses of AI and may generate more first-mover advantages.

Since there is high-cost, up-front research and development for acquiring AI systems that will enable rapid power projection, Horowitz tends to believe that AI will indeed produce significant first-mover military advantages despite private sector diffusions. He states that the integration of AI into early-warning systems and its ability to aid in rapid targeting could also affect crisis stability and nuclear weapons, but he conspicuously does not elaborate on the topic. Recognizing these advantages helps predict outcomes when comparing the asymmetrical abilities of competing states.

Elaborating on the ideas that Horowitz presented, Elsa Kania believes that AI "should be recognized as a strategic technology with implications for national competitiveness that extend well beyond the military domain" (Kania, 2018: 11). States may apply it to a wide range of objectives, including military, economic, and educational programing. As a policy response, Kania suggests that great-power states seek opportunities to cooperate on AI issues and to prevent escalation of AI warfare. For instance, the United Nations Group of Governmental Experts provides one means of accomplishing this goal. The working group brings together over twenty states to engage in conversations regarding state behavior in cyberspace as it enables "vital discussions of core concepts and questions, particularly ethical issues and human control, and hopefully can create a critical foundation for future engagement" (Kania, 2018: 18).

Separately from the intersection of the two technologies, Kania provides an analogy between the rise of AI and that of nuclear weapons. The advent of nuclear weapons posed a similar threat to strategic stability, and during the height of the Cold War and following the collapse of the Soviet Union, nuclear weapons states discussed shared concerns and aversions. Kania believes that similar cooperation and discussion regarding pragmatic measures aimed at risk reduction will be equally beneficial. However, due to the ambiguity concerning formalized definitions of AI and the wide range of AI capabilities, cooperation in this realm may be even more difficult than that for nuclear weapons, and this will require a greater degree of transparency regarding intent and capabilities.

Adding to the conversation, James Johnson discusses the deterministic and dramatic potential effects, from the tactical to the strategic level, that AI will have on military power, strategy, and the global balance. He argues that if "left unchecked, the uncertainties and vulnerabilities created by the rapid proliferation and diffusion of AI could become a major potential source of instability and great power strategic rivalry"

(Johnson, 2019: 148). This is similar to Horowitz's thesis, but Johnson focuses on managing escalation and unique risks of AI rather than first-mover advantages.

Specifically related to nuclear deterrence, Johnson discusses the integration of AI into early-warning systems. This application may accelerate the decision-making process and the stages of the escalation ladder to employ a nuclear attack. In addition, "a state could deploy long-range, offensive conventional missile salvos enhanced by big data analytics, cyber capabilities, and AI-augmented autonomous weapons, and then use its missile defenses to mop-up an adversary's remaining retaliatory capabilities" (Ibid.: 152).

Both of these scenarios could have a negative impact on nuclear crisis stability as they provide conditions that could offer advantages for a state to strike first against an adversary. Furthermore, Johnson holds that states may soon develop AI-augmented weapons systems. These systems, along with AI-enabled early-warning systems and sensors, "could adversely impact the international security and, potentially, crisis stability at a nuclear level of warfare" (Ibid.: 159).

Finally, utilizing scenarios regarding aggression between Russia and NATO, Michael O'Hanlon (2018) illustrates how AI will alter the future of warfare. He discusses the potential for escalation following possible Russian attacks on the Baltic States, which ranges from minimal ground conflicts to nuclear warfare. While O'Hanlon believes there are appropriate measures in place, coming from both NATO and Russian deterrence policies, that will prevent escalation to war on a nuclear level, the introduction of AI could seriously damage this crisis stability. According to O'Hanlon, there is currently a relative balance of tactical [*sic*] capabilities between nuclear weapons states. One country might improve its missile defense capabilities, but an adversary might produce a new nuclear missile with improved agility and speed.

This present balance upholds stability between states, as there cannot likely be a clear winner in a nuclear exchange. Unfortunately, as O'Hanlon argues, the application of AI to military systems undermines this stability for a number of reasons. First, "it seems implausible that arms control agreements [regarding AI] would prevent the development and deployment of… autonomous systems" (O'Hanlon, 2018: 8). States would feel powerful incentives to produce autonomous systems because the mere possibility of another state accomplishing this feat first would place the first at a severe disadvantage.

Second, at present, there is no clear response to an attack made with AI. This dilemma mirrors the cyber realm since an attack that utilizes AI or cyber can come in many different forms and degrees of severity, rendering it difficult for a state to formulate a response that is appropriate and that does not escalate the conflict. Finally, "the degree of difficulty [of winning a war with AI] would be quite considerable and the degree of escalatory risk highly unsettling" (Ibid.: 21). Again, like cyber warfare, AI introduces a high level of ambiguity to conflict since it is not clear what an AI attack will look like or the form it will take.

Stephen Cimbala (2012) presents an argument that is in line with O'Hanlon's. Cimbala holds that the uncertainty that AI will bring to the battlefield will undermine stability. Overall, O'Hanlon's various scenarios revolving around the implementation of AI into military systems effectively demonstrate how AI will affect conflict at the tactical level and how these tactical repercussions alter strategic stability.

The Likely Asymmetric Acquisition of Capabilities

In addition to projecting the impacts of AI, Kania (2018) provides analysis on how the U.S., China, and Russia have embarked on an AI arms race. There is ongoing military competition between these states as they attempt to advance their AI capabilities, and the United States is arguably but likely the current leader. However, China is prioritizing military innovation and actively seeking a wide range of defense applications of AI, placing them as a close second to the United States in this competition. Additionally, Russia's pursuits in the same realm are advancing at a rapid pace. Kania's underlying argument lies in the idea that the term "arms race" is too simplistic to capture the strategic consequences of the AI revolution.

Supporting this claim and building upon Horowitz, Kania states that AI is not a weapon in itself. Rather, AI is a utility that states can utilize to enhance their existing military capabilities. In this sense, AI is more synonymous with electricity or the steam engine than a specific weapons system since it is only useful due to its applications. States cannot launch AI at another state, but they can employ autonomous planes, self-guided nuclear missiles, or various other weapons systems with AI.

Like Kania, Adrian Pecotic (2019) addresses the apparent race for AI between the United States, Russia, and China. However, instead of calling for global cooperation and dialogue as Kania did, Pecotic focuses on different approaches to AI implementation and claims that whichever state successfully incorporates AI into their military systems will secure significant military advantages. He admits that "it's tough to tell what sort of advantage is at stake, because we don't know what sort of thing AI will turn out to be" (Pecotic, 2019: 3). Nonetheless, there will be advantages following the acquisition of AI capabilities, and they may take the form of autonomous drones, more efficient supply changes, or autonomous nuclear missiles.

Additionally, just as Kania predicted, Pecotic believes that advances in AI may resemble the nuclear weapons buildup of the Cold War. He suggests that the main competition will be between the United States and China and does not have the same solution for the situation as Kania provided. Pecotic holds that "once China or the United States is confident in a stable lead [in AI], they will have few incentives to compromise or share technology" (Ibid.: 22).

Defining Crisis Stability

A significant number of scholars and practitioners have spent time defining crisis stability. This study will focus on the definition presented by Thomas Schelling, which has prevailed throughout the evolution of nuclear deterrence literature. As Schelling famously stated, "the reciprocal fear of surprise attack" may drive states to launch a presumptive strike. In this case, "fear that the other may be about to strike in the mistaken belief that [one side is] about to strike gives [this side] a motive for striking, and so justifies the other's motive" (Schelling, 1958: 1).

This scenario describes the essence of crisis stability, which exists when neither side feels the pressure to strike the other out of fear that the other is about to strike. Furthermore, the acquisition of new offensive capabilities threatens crisis stability. As Robert Jervis describes, under circumstances in which a state fears an adversarial attack, "the state's efforts to deter the adversary or protect itself in case of war would make war more likely.

Observing the state's preparations, the adversary would see the danger of war increasing and would itself make ready to strike" (Jervis, 1993: 242).

The introduction of AI into nuclear systems may create the circumstances Jervis describes. As the literature from Horowitz, Kania, and others has demonstrated, AI is a technology enhancer that possesses unknown potential and is clouded with uncertainty. It will be very difficult for states to predict how others will utilize AI, how they will rely on AI, and how they will program their automated machines. Altogether, AI will introduce many unknowns in a state's calculations when predicting an adversarial attack. This uncertainty may create situations in which crisis stability diminishes.

As Glenn Kent and David Thaler describe, crisis *instability* is the "condition that exists when either leader feels pressure because of emotion, uncertainty, miscalculation, misperception, or the posture of forces to strike first to avoid the worse consequence of incurring a first strike" (Kent and Thaler, 1989: xviii). Therefore, the uncertainty and probability of miscalculation that comes with the introduction of AI to nuclear systems would likely increase crisis instability between states.

HISTORICAL CASE STUDIES

Three specific historical cases can help predict the effects of the onset of AI in nuclear weapons systems. These cases reflect the introduction of new technologies and strategies that risked nuclear escalation but in which great power states managed to prevent conflict. The lessons learned from each case will be useful in formulating predictions, but it is important to note that AI will bring extreme uncertainty that previous changes in nuclear deterrence have not.

First, the Soviet acquisition of ICBMs during the Cold War and the ensuing American "window of vulnerability" mirror the possible advent of AI in nuclear weapons systems. According to Cold War deterrence scholars Richard Lebow and Janice Stein, "By the end of the 1960s, the Soviet Strategic Rocket Forces had deployed enough ICBMs to destroy about half of the population and industry of the United States. It had achieved the capability that McNamara considered essential for MAD [mutually assured destruction]. Sometime in the 1970s the Soviet Union achieved rough strategic parity" (Lebow and Stein, 1995: 173).

In response, the United States pursued a path to build up their stockpile of ICBMs and embark in counterforce doctrine (Johnson, 1983). This period marked uncertainty for the United States, just as the implementation of AI will do for any adversary. However, the Soviet advantage did *not* drive the United States to attack the Soviet Union or develop a new technology that would counteract the ICBMs, which would be in line with the hypothesis of this study. Instead, the United States embarked on a new strategy and aimed to reinstate a balance of power. Nonetheless, AI will introduce a level of uncertainty that ICBMs did not, meaning the two technologies may not create similar environments following their introduction to a state's nuclear weapons complex.

Secondly, President Reagan's counterforce strategies along with the American advantage in surveillance techniques during the Cold War provide another case study to help predict the effects of AI on deterrence. Counterforce strategies offer a unique asymmetry between adversaries, as "one effect of counterforce strategies… is that they provide a rational motive for waging a conventional war even when one expects to lose" (Wagner, 1991: 748). At the same time, according to Austin Long and Brendan Rittenhouse Green (2014), the United States had a significant advantage over the Soviet Union in the realm of intelligence and surveillance regarding nuclear weapons. This came in the forms of ocean surveillance technology for submarines, SIGINT, and Rapidly Deployable Surveillance System units. Altogether, these American advantages along with U.S. counterforce strategy demonstrate a path that adversaries may pursue in order to maximize the costs of waging war against them.

As Wagner (1991) described, counterforce is useful even when a state is losing, so it is a useful deterrent against an adversary. This case represents how adversaries may react if another acquires AI capabilities. Rather than purely pursuing the same route as an adversary, another may alter their strategy or develop a technology that helps counter others.

Finally, veering away from nuclear deterrence, the American and Chinese acquisition of space capabilities surrounding the turn of the century offers another comparison to the future mutual acquisition of AI capabilities. Following China's milestone as it became the third country to launch a person into space in 2003, the United States had a clear choice to make: "America could reach out to cooperate, proposing joint space exploration projects, or it could restrict collaboration and perhaps even decide to pursue a space race akin to the 1960s competition against the Soviet Union" (Moskowitz, 2011).

Out of fear, the United States resisted cooperation. It believed that collaboration would provide a greater technological benefit to China and would create a large risk for the United States. However, Clara Moskowitz (2011) recommends that the United States should view space as only one aspect in the overall U.S.-China relationship. Instead of comparing advantages solely in the context of space, Americans should see collaboration as a way to strengthen ties, increase cooperation in other fields, and maintain stability between the two countries.

Similar to the previous case studies, the Chinese acquisition of space capabilities did not lead to acts of aggression. Altogether, the three cases do not point to the likelihood of AI leading to a breaking point in crisis stability between the United States and China or the United States and Russia. However, as the rest of this study will conclude, AI will introduce more technological and strategic uncertainty than past technologies.

When the Soviet Union developed ICBMs or the Chinese put a person in space, the United States understood the technology, but an ICBM or another feat that the United States had previously accomplished is significantly easier to evaluate than AI capabilities. Rather, AI may appear in a variety of realms as it is not a technology within itself, like Horowitz and Kania remind us. AI is an enabler that will introduce indefinite amounts of uncertainty between adversaries and become far more dangerous to crisis stability than the technologies presented in these case studies.

OPERATIONALIZATION

In order to predict the impact of asymmetric acquisition of AI capabilities through a systematic method, this paper will utilize a series of tables that register possible advantages within the varying uses of AI in nuclear systems for different states. Rather than simply recognizing that there may be qualitative variances regarding how states implement AI, this method illustrates the degree to which different capabilities will impact crisis stability. Although there are a variety of techniques for which a state may incorporate AI into its numerous nuclear systems, this system of operationalization will focus on five primary, general, and likely uses of AI: (1) unmanned nuclear delivery systems, (2) nuclear early warning systems, (3) command and control, (4) data processing, and (5) nuclear weapons countermeasures. This is not to say that there are no other possible applications of AI for nuclear systems, simply that these capabilities provide areas in which major-power states may acquire distinct advantages. The methodology will utilize the five categories as examples for how acquisition of varying proficiencies produces asymmetry and ultimately harms nuclear crisis stability.

In order to compare capabilities between two states, it is beneficial to focus on a state's advantage through AI-enhancement and its reliance upon AI for each category. Simply prioritizing the possession of an AI-enhanced capability neglects the asymmetry that may arise from variances in how states utilize AI-systems. For example, if a state utilizes AI to assist its early warning systems while another relies on AI in its early warning systems to make final decisions (without a human in the loop), the latter has a much stronger reliance upon AI. Similarly, if both states possess AI-enhanced nuclear weapons countermeasures, one may possess an extremely reliable system while the other's system may be faulty or incomplete. In this case, one state has a distinctive advantage over the other regarding countermeasures. Therefore, some consideration of reliance and consequent advantage provides a better reference for measuring asymmetry than pure possession of the technology.

When addressing the total degree of asymmetry that varying capabilities produce, it is important to note that some capabilities have greater weight than others. For instance, the utilization of AI-enhanced unmanned delivery vehicles may worry an adversary more than the possession of AI-enhanced data processing systems. Consequently, when measuring asymmetry, or perceived asymmetry, it is useful to weigh delivery vehicles as providing greater advantage than data processing abilities.

In order to combine these factors, the presence of advantages and their respective weights, Table 1, below, presents a method of predicting asymmetry between states. In this table, the advantages of both states regarding varying capabilities are registered for each category, with "1" representing an advantage while "0" represents the lack thereof. If both states record a "0," then neither state holds a distinct advantage over the other in the respective category. The numbers recorded as "weights of capability" represent the impact that the presence of an advantage in the specific category will have on the total asymmetry in the overall relationship. Finally, if there is a presence of an advantage, that category will produce a score of asymmetry equal to its assigned weight. The overall table output will be the sum of each capability's recorded score of asymmetry.

As opposed to presenting an argument for which state will possess future advantage in each category and how each category should be weighted exactly, this study merely proposes predictions for the purpose of demonstrating the likely increases in asymmetry. These guesses show how acquisitions of varying capabilities may populate this table following how states incorporate AI into their nuclear weapons systems. In this sense, Tables 2-3, below, demonstrate a methodology or tool for predicting asymmetry. Using placeholder values for how the United States, China, and Russia will acquire AI, the tables indicate possible asymmetry that may arise between these major-power states.

The hypothetical relationship between the United States and Russia (in Table 3) scored a 7 while that of the United States and China (in Table 2) scored an 8. When compared next to each other, these values do not have any significance because neither the category advantages nor the weights are tied to a consistent interval level of measurement. The fact that China's score is higher than Russia's does not mean that there is more asymmetry in that relationship.

Rather, these values have significance when compared to other values from the same tables when the inputs change. That is, longitudinal changes (over time) in table output are more meaningful than cross-dyad differences in any single year. The various possible inputs (advantages in capabilities along with the weights) in a specific table dictate the overall table output.

When the U.S.-China analysis produces a score of 8, the policy takeaway should focus on methods to reduce the table output over time, which could occur from the removal of or the emergence of new advantages. A scenario that produces higher table outputs for the same dyad indicates higher levels of asymmetry. The desire to decrease asymmetry would entail efforts to minimize the table outputs so that they approach zero in every category of capability.

Consequences

As this method of predicting asymmetry between the selected major-power states demonstrates, qualitative variance in acquiring AI-enhanced nuclear weapons will increase asymmetry within these relationships. This asymmetry will undoubtedly increase the uncertainty of these states when analyzing the capabilities of an adversary due to the fact that AI is a format of technology, a kind of utility that contains a wide array of unknown variables. A state may be uncertain of how an adversary's AI systems function, the degree to which they rely on AI in these systems, the decision-making autonomy given to the system, etc.

Referring to Kent and Thaler's definition of nuclear crisis stability, that "crisis instability is the condition that exists when either leader feels pressure because of emotion, uncertainty, miscalculation, misperception, or the posture of forces to *strike first* to avoid the worse consequence of incurring a first strike," this increase of uncertainty from AI asymmetry will negatively affect nuclear crisis stability. It follows that as asymmetry increases (or the table outputs presented increase,) the degree of uncertainty will increase, and nuclear crisis stability will continuously decrease.

Counterarguments

After reviewing the case studies presented in this study, it may not seem as if asymmetry truly effects crisis stability to the point that an actor will utilize a preemptive strike. In the historical cases of Soviet acquisition of ICBM's, the American employment of counterforce strategies, and the Chinese rise in space power, no state chose to strike its adversary. These results would lead to the conclusion that asymmetric acquisition of capabilities does not significantly diminish nuclear crisis stability. Since the dawn of the nuclear age, great powers have always found a way to avoid worst case scenarios that might be brought about from rapid technological change.

However, AI provides more uncertainty regarding intention and capabilities than the technologies presented in the old case studies. For example, when the Soviet Union acquired ICBMs, the United States recognized what this meant for their security posture. It was clear what advantage this weapon system provided the Soviets, so the level of uncertainty was relatively low.

In the case of AI, as previously mentioned, states will struggle to determine how states will be able to utilize autonomous systems. Intentions, capabilities, and reliance will all be indeterminate without transparency from great power states that acquire AI. For this reason, AI introduces a new level of uncertainty regarding capabilities that is unprecedented and may have unique effects on nuclear crisis stability. More specifically, the uncertainty surrounding AI-enhanced systems will decrease nuclear crisis stability in a way that previously existing technologies have not.

CONCLUSION AND SUGGESTIONS

To reiterate, the method presented in this study demonstrates how crisis stability will decrease as great-power states asymmetrically acquire AI-enhanced technologies and incorporate them—in qualitatively different ways—into their nuclear weapons systems. For policy, this introduces the desire to limit asymmetry between major-power states.

In order for the United States to achieve this goal and preserve nuclear crisis stability, it could pursue three distinct actions. First, it might enhance its intelligence gathering methods that allow it to better understand adversaries' intentions and capabilities regarding AI-enhanced systems. By doing so, the United States will increase its ability to accurately predict AI paths of its adversaries. The United States should then aim to limit asymmetry between itself and adversaries by increasing its own capabilities in the same areas as adversaries. Using strengthened intelligence from the first step would allow the United States to know which capabilities its adversaries are developing, and increase its ability to counter, to stay on par with those adversaries.

Finally, and most importantly, the United States and the international community could work to place controls and regulations on the incorporation of AI in nuclear weapons systems in a bid to maintain transparency. This final step would decrease the number of areas in which states could develop AI-systems and therefore reduce the chances that a state might achieve an advantage over the United States. Altogether, these prudent steps would limit asymmetry between major-power states, prevent uncertainty regarding adversarial AI-enhanced nuclear systems, and ultimately help maintain nuclear crisis stability.

Table 1: Example

	Capability #1	Capability #2	Capability #3
State #1	Advantage: 1	0	0
State #2	No Advantage: 0	1	0
Presence of Advantage?	Yes: 1	1	0
Weight of Capability	1	.5	2
Asymmetry Created	1 * 1 = 1	.5	0

Table Output (Sum of Asymmetry Created): 1.5

Table 2: U.S.-China

AI Enhanced Capability:	Delivery Vehicles	Early Warning Systems	Command & Control	Data Processing	Counter-measures
U.S.	0	0	0	1	0
China	1	1	0	0	1
Presence of Adv.	1	1	0	1	1
Weight of Cap.	3	2	1	1	2
Asymmetry Created	3	2	0	1	2

Table Output: 8

Table 3: U.S.-Russia

AI Enhanced Capability:	Delivery Vehicles	Early Warning Systems	Command & Control	Data Processing	Counter-measures
U.S.	0	1	0	1	0
Russia	1	0	1	0	0
Presence of Adv.	1	1	1	1	0
Weight of Cap.	3	2	1	1	2
Asymmetry Created	3	2	1	1	0

Table Output: 7

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