Incorporating Gaming into Research Programs in International Relations: Repetition and Multi-Method Analysis

E. M. Bartels

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Abstract:

Existing literature on the use of games to support research on international relations is largely disconnected from the academic literature on research design generally, and multi-method research design in particular. The majority of gaming literature currently comes out of the interdisciplinary practitioner community, who have generally been focused on pragmatic considerations. Popular works on game design often come out of the commercial gaming industry, where research considerations are not a core driver of design choices. Finally, works from international relations tend to focus on games as a teaching tool or on games as they have contributed to specific avenues of research. It is only recently that the use of games as a tool for research is being addressed as a subject of study it its own right within contemporary political science. This paper expands on previous work conceptualizing games within social science research design to discuss how games can be integrated into broader studies by exploring two approaches: repeated games and games in multi-methods studies.

Existing literature on the use of games to support research on international relations is largely disconnected from the academic literature on research design generally, and multi-method research design in particular. The majority of gaming literature currently comes out of the interdisciplinary practitioner community, who have generally been focused on pragmatic considerations.[1] Popular works on game design often come out of the commercial gaming industry, where research considerations are not a core driver of design choices.[2] Finally, works from international relations tend to focus on games as a teaching tool[3] or on games as they contributed to specific avenues of research.[4] It is only recently that the use of games as a tool for research is being addressed as a subject of study in its own right within contemporary political science.[5] As I have previously argued,[6] this turn towards integrating games into the frameworks and concepts applied to other tools for social science research is critical to ensuring that the insights drawn from games are sound, as well as for making the tool more accessible to new researchers.

This paper expands on previous work conceptualizing games within social science research design to discuss how games can be integrated into broader studies by exploring three approaches: repeated games, serial games, and games in multi-methods studies. First, I discuss why it might be valuable to run a game more than once—and why value of doing so might differ depending on the information to be produced. I then turn to discussing studies that use multiple

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[1] Key practitioner texts include: Peter P. Perla, *The Art of War Gaming: A Guide for Professionals and Hobbyists*, ed. John Curry, 2nd ed. (History of Wargaming Project, 2011); Matthew B. Caffrey, *On Wargaming: How Wargames Have Shaped History and How They May Shape the Future* (Newport, RI: Naval War College Press, 2019); Graham Longley Brown, *Successful Professional Wargames: A Practitioner's Guide*, ed. John Curry (The History of Wargaming Project, 2019).

[2] For notable examples, see: Katie Salen Tekinbas and Eric Zimmerman, *Rules of Play: Game Design Fundamentals* (Cambridge MA: MIT Press, 2003); George Skaff Elias, Richard Garfield, and K. Robert Gutschera, *Characteristics of Games* (Cambridge MA: MIT Press, 2012); Engelstein. Geoffrey and Issac Shalev, *Building Blocks of Tabletop Game Design: An Encyclopedia of Mechanisms* (Boca Raton, FL: CRC Press, 2019).

[3] Victor Asal, "Playing Games with International Relations," *International Studies Perspectives* 6, no. 3 (2005).

[4] For recent work, see: Reid B.C. Pauly, "Would U.S. Leaders Push the Button? Wargames and the Sources of Nuclear Restraint," *International Security* 43, no. 2 (2018). Jacquelyn G. Schneider, "Cyber Attacks on Critical Infrastructure: Insights from War Gaming," *War on the Rocks*, July 26 2017. Andrew W. Reddie et al., "Next-Generation Wargames: Technology Enables New Research Designs, and More Data," *Science* 362, no. 6421 (2018); Erik Lin-Greenberg, "(War)Game of Drones: Remote Warfighting Technology and Escalation Control Evidence from Wargames," (SSRN, 2019); Benjamin Jensen and Brandon Valeriano, "Cyber Escalation Dynamics: Results from War Game Experiments," in *International Studies Association* (Toronto, Canada2019).

[5] Recent work in this vein includes: Ivanka Barzashka, "Wargaming: How to Turn Vogue into Science," *Bulletin of the Atomic Scientists*2019. Sawyer Judge, "The Wargaming Guild: How the Nature of a Disipline Impacts Its Craft and Whether It Matters" (Georgetown University, 2019). Elizabeth M. Bartels, "Building Better Games for National Security Policy Analysis: Towards a Social Scientific Understanding" (Pardee RAND Graduate School, 2020). and Erik Lin-Greenberg, Reid B.C. Pauly, and Jacquelyn Schneider, "Wargaming for Political Science Research," in *APAS Annual Conference* (Virtual2020).

[6] Bartels, "Building Better Games for National Security Policy Analysis: Towards a Social Scientific Understanding."

tools, whether multiple types of games or games in conjunction with other approaches to conducting research.

Establishing Games within a Framework for Social Science Inquiry

This paper builds on a conceptual framework previously developed in Bartels 2020, which leverages Jackson 2010's framework for describing different philosophies of inquiry in international relations[7] to describe three potential roles for games in social science inquiry. As other works on methods using Jackson's typology have established, the same method can be used across multiple philosophical frames, but the application of the method is often different.[8] In examining the sparse theoretical literature on policy gaming, I find evidence of positivist, critical realist, and analyticist approaches to gaming for policy research.

First, it is important to be clear that despite claims to the contrary, policy games are designed to produce information about causality that can, to at least some degree, be transferred to the real world. These claims stem not from the nature of games themselves, but rather from their application in policy settings. If we claim that games are helpful to decisionmakers in navigating the future,[9] they must in some way arm decisionmakers with correct information about cause and effect that can inform future decisions.[10] That is different than a guarantee of successful prediction of a specific future, since the complexity of many interacting events, many outside the control of the decisionmaker, leads to outcomes that are influenced by more than just their decision.[11] Existing work opts to frame this limitation as games providing *indicative* rather than *predictive* information,[12] an approach with which I generally agree. However, it is important to be clear that the work being done by these games is fundamentally about establishing causal relationships. This working paper is one of several recent efforts to contextualize games within the causal inference literature.[13]

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[7] Patrick Thaddeus Jackson, "The Conduct of Inquiry in International Relations: Philosophy of Science and Its Implications for the Study of World Politics," (New York, NY: Routledge, 2011).

[8] Derek Beach and Rasmus Brun Pedersen, *Causal Case Study Methods: Foundations and Guidelines for Comparing, Matching, and Tracing* (Ann Arbor, MI: University of Michigan Press, 2016). pp 11-13

[9] Robert Work and Paul Selva, "Revitalizing Wargaming Is Necessary to Be Prepared for Future Wars," *War on the Rocks*, December 8 2015.

[10] Robert C. Rubel, "Epistemology of War Gaming," *Naval War College Review* 59, no. 2 (2006). p 110

[11] Ibid. p 110

[12] Ibid. p 112 and Stacie Pettyjohn and Becca Wasser, "The Promise of Structured Strategic Wargames: Moving Beyond the Seminiar," in *International Studies Association* (San Francisco2018).

[13] Lin-Greenberg, Pauly, and Schneider, "Wargaming for Political Science Research."

Positivism

The most common of the positions is positivism. Positivists are interested in understanding whether general, law-like statements about causality between discrete factors can correctly describe observed patterns.[14] Put differently, this tradition attempts to describe the difference in some outcome Y, based on the presence of different values of some causal factor X. This perspective links explanation with predictions, since once a causal relationship between factors is established it can be generalized to other relevant contexts.[15] Jackson highlights the space in this tradition for qualitative evidence and modes of analysis that focus on intervening mechanisms, making for a much broader view than the narrow perspective sometimes ascribed to this approach.[16] While Jackson's work notes the dominance of this position within academic settings, it's worth noting its even greater dominance in policy circles. The ability to generalize a causal pattern offers decisionmakers the possibility of prediction, to see into the future and correctly project how a policy is likely to play out and enable that knowledge to inform their decision today.

Perhaps unsurprisingly given the dominance of positivist thought in other areas of empirical social science and policy analysis, there is a substantial community of gamers operating in this mode. In particular, a sizable number of "experimental," "quasi-experimental," and "structured comparison" games attempt to demonstrate the influence of a specific factor on decisionmaking and other outcomes of interest by systematically varying game conditions and observing the effect on player discussions and choices.[17] Generally, these games focus relatively narrowly on demonstrating the connection between a difference in a single key factor and outcomes (for example, linking the presence of a drone vs. piloted aircraft with decisions that were more or less escalatory[18]) or the connection between the type of analysis provided to decisionmakers with the arguments used in decisionmaking (for example, the impact of broad vs. deep analysis on decisionmaking[19]). In other words, analysis from these games seeks to provide evidence of a

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[14] Jackson, "The Conduct of Inquiry in International Relations: Philosophy of Science and Its Implications for the Study of World Politics." p 108

[15] Ibid. p 111

[16] Ibid. p 109

[17] For examples of this approach, see: Peter Perla, Michael Markowitz, and Christopher Weuve, "Game-Based Experimentation for Research in Command and Control and Shared Situational Awareness," (Alexandria, VA: CNA, 2005); Reddie et al., "Next-Generation Wargames: Technology Enables New Research Designs, and More Data."; Erik Lin-Greenberg, "Game of Drones: What Experimental Wargames Reveal About Drones and Escalation," *War on the Rocks*2019; Elizabeth M. Bartels et al., "Do Differing Analyses Change the Decision?: Using a Game to Assess Whether Differing Analytic Approaches Improve Decisionmaking," (Santa Monica, CA: RAND Corporation, 2019); Dominic D. P. Johnson et al., "Overconfidence in Wargames: Experimental Evidence on Expectations, Aggression, Gender, and Testosterone," *Proceedings of the Royal Society* 273 (2006).

[18] Lin-Greenberg, "Game of Drones: What Experimental Wargames Reveal About Drones and Escalation."

[19] Bartels et al., "Do Differing Analyses Change the Decision?: Using a Game to Assess Whether Differing Analytic Approaches Improve Decisionmaking."

causal relationship by tracing patterns of observed behavior in the game and making claims about other cases where the pattern might hold.

Many within the game design community have disputed the validity of using games in this frame. However, often these concerns have more to do with specific limitations of the approach rather than the appropriateness of the underlying philosophy. Perhaps the most frequent complaint is that the artificiality of game scenarios and role-playing prevents appropriate generalization of game results onto real-world settings.[20] However, this problem is hardly unique to games, since many laboratory experiments also take place in artificial environments.[21] In fact, games may replicate more of the actual decisionmaking interactions than other laboratory environments and thus produce findings that are more generalizable because they can better mimic interpersonal interactions and environmental complexity at the cost of some degree of internal validity.[22] Finally, the argument is made that the focus on crises and other extraordinary events inherently focuses games on "novelty and uniqueness";[23] there is a limited call among game sponsors for generalizability. While it is true that the scope of application may be somewhat limited, such concerns have hardly prevented positivist work from occurring using other policy analysis tools. Taken together, the majority of arguments made against positivist approaches to games are concerns about how such work is done rather than the viability of the philosophical approach.

Critical Realism

In contrast to the positivist approaches, critical realist accounts deviate from the core claims of phenomenalism to argue that real, but unobservable, phenomena ranging from quarks in physics to social structures in social sciences can be studied scientifically through a process of *abduction*. In order to draw inferences about these unobservables, scientists gather evidence from the surrounding system and make a plausible causal explanation—often in the form of a mechanism—based on all available evidence. As the available evidence changes, the causal theory may evolve; however the theory is still fundamentally unproven by this process— abduction cannot demonstrate truth, only plausibility.[24] This approach moves away from the normal scientific assumption of generalizability, to focus instead on building an understanding of

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[20] Robert A. Levine, Thomas C. Schelling, and William M. Jones, "Crisis Games 27 Years Later : Plus C'est Deja Vu," (Santa Monica, CA: RAND Corporation, 1991). pp 2-12 and Edward Parson, "What Can You Learn from a Game?," in *Wise Choices: Decisions, Games, and Negotiations*, ed. Ralpj L. Keeney Richard J. Zeckhauser, James K. Sebenius (Boston: Harvard Business School Press, 1996). p 237

[21] For example, consider widespread debates over the generalizability of behavior research based on populations of college students.

[22] Lin-Greenberg, Pauly, and Schneider, "Wargaming for Political Science Research."

[23] Parson, "What Can You Learn from a Game?." pp 238-239

[24] Jackson, "The Conduct of Inquiry in International Relations: Philosophy of Science and Its Implications for the Study of World Politics." pp 82-83

the "specific, contingent, and complex."[25] This also means that adherents of critical realism argue that theories cannot predict, they can only demonstrate the limits of what is possible, which is valuable if previously unrecognized.[26] While critical realism is a far less popular frame for policy analysis than positivism, it has been attractive to some because of its interest in mechanisms that are a good fit with studies of processes.[27] It is also often used during the hypothesis generation process.

Scholars of this tradition treat games as tools for hypothesis generation through abduction. The most notable example of this approach can be found in Jon Compton's work, which stresses that the complexity of war is best understood as a system where "the whole is greater than the sum of its parts."[28] Part of the utility of games stems from being able to observe the system created by competing actors in a specific environment. As a result, rather than trying to separate out individual factors as in a positivist approach, this approach argues that games work best when they consider broader complexes of causal factors and the processes by which these factors cause different outcomes. In other words, this approach is focused on causal mechanisms rather than causal factors. These mechanisms also do not have to be directly observed to be real. For example, a key output of games in this mode is a "theory of success"—that is, a causal argument about what sets of actions are likely to produce the desired result in a specific conflict.[29] The underlying strategy may not be directly articulated by players, but the individual components and consequences can be observed and the causal force of the strategy analyzed as a result.

In addition to articulating the core understanding of causality espoused by critical realism, this approach to gaming also articulates a number of other claims consistent with this philosophical perspective. For example, Compton also argues that games should not be seen as a deductive or inductive process, but rather as following an abductive logic where a theory is postulated as the best explanation for the available evidence.[30] He stresses that this means that games are a tool for hypothesis generation but cannot contribute to proving an abducted theory since a plausible explanation can still prove to be wrong.[31] He also argues against attempts at broad generalization, arguing for narrow generalization to similar cases and stresses that games

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[25] Aaron Frank, "The Philosophy of Science and Intelligence: Rethinking Science in Support of Intelligence," in *International Studies Association Annual Conference* (San Diego, CA2012). p 38

[26] Jackson, "The Conduct of Inquiry in International Relations: Philosophy of Science and Its Implications for the Study of World Politics." p 111

[27] For some recent examples of work in this vein, see: Phil McEvoy and David Richards, "Critical Realism: A Way Forward for Evaluation Research in Nursing?," *Journal of advanced Nursing* 43, no. 4 (2003). Megan Lourie and Elizanth Rata, "Using a Realist Methodology in Policy Analysis," *Education Philosophy and Theory* 49, no. 1 (2017).

[28] Jon Compton, "Analytical Gaming," (2014). p 8

[29] Interviews with Jon Compton, Washington, DC, August 2018 and Phil Pournelle, Washington, DC, March 2019.

[30] Compton, "Analytical Gaming." p 6

[31] Ibid. p 6

show what "can" or "may" happen if those specific conditions occur rather than offering any type of law-like generalization.[32]

Analyticism

Analyticism moves away from positivism in a different direction than critical realism by rejecting the separation of mind and world. Instead, the approach argues that theory is an act of sensemaking that tries to explain what is being observed.[33] Researchers in this mode immerse themselves in a problem and then develop an "oversimplification" of the observed complexities which can then be used to produce a case-specific narrative of causality.[34] In other words, researchers in the frame develop models that are simple, and thus inherently non-representative, of the true complexity of the world, but are useful to the researcher for the particular purpose at hand. Such models are rejected not for being wrong but for not being useful in explaining the specific case at issue.[35] If a model is not sufficiently similar to the case to be useful, the model may be updated, or the researcher might generate an argument using the specifics of the case as to why the model does not apply.[36]

Perhaps the most common perspective in the practitioner literature takes this third approach. The researchers in this mode describe games as a type of model following many of the forms of argumentation advocated in the analyticist mode of science. Rather than describing games as an opportunity to observe differences or trace mechanisms that can advance our understanding of causality, this perspective sees games as an opportunity to construct a model of the key causal forces at play. In effect, games yield artificial political-military histories about how events could unfold that are built by "examin[ing] why these events occurred—the combinations of player decisions and umpire determinations that produced them"[37] in order to generate a causal narrative. For example, game observations can lead to narratives about how groups make competitive decisions, which can then be considered as an ideal description that might be helpful in explaining real world decisions.[38] In other words, the outcome of analysis based on this type of game is the model of the problem developed both by the initial game design and by the contributions of players which flesh out how it evolves over time.

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[32] Ibid. p 5

[33] Jackson, "The Conduct of Inquiry in International Relations: Philosophy of Science and Its Implications for the Study of World Politics." p 114

[34] Ibid. p 142

[35] Ibid. p 143-144

[36] Ibid. p 147

[37] Rubel, "Epistemology of War Gaming." p 117

[38] A famous example of this type of finding is found in Levine, Schelling, and Jones, "Crisis Games 27 Years Later : Plus C'est Deja Vu." pp 28-30

Similar to other work in the analyticist mode, this perspective stresses that valid games are those that produce "useful" knowledge for a specific purpose, rather than making any general claim about games producing "true" information.[39] In this model of inquiry, game designers and participants intentionally "distill" a problem by simplifying it enough that it becomes tractable and useful.[40] So long as the game attempts to "represent reality to the degree necessary to explore the warfare phenomena in which we are interested,"[41] these simplifications do not prevent us from advancing understanding through the use of games. However, as a result of the focus on the game as a simplified mode, this view also stresses that information from games is conditional[42]--it may be helpful in other contexts, but there should be no assumption that it will describe a generalized causal relationship.

The Value of Repeating Games

What additional information might we obtain by repeating a game, and what does that imply about how we are learning from it? First, it is worth being clear about what is meant by a repeated game. I use the term to refer to using the same game design using the same logic on inquiry. There will always be changes between runs of a game. Most obviously players will be different, either because new players are recruited, or their decisions in the new run will have been changed by the previous play of the game. Additional changes to game materials are likely to occur as players provide feedback that improves the practical functioning of the game, corrects factual errors, or refines the design. However major design elements, and most importantly, why the information from the game in interpreted to advance knowledge, should be consistent.

In the practitioner community, there is little theoretical work on how often to run a game. This is often treated as a purely pragmatic consideration—with the argument being that you run the games as many times as you can given available resources,[43] and the recognition that quite often this means games are only run once. Often, the number of repetitions is determined primarily by resources or other logistical considerations rather than by the research design of the study. There are few clear articulations of what may be gained through repetition, how much analytic value it provides, and whether the gains are the same between different types of games to support alternative arguments. This section attempts to lay out a logic for what might be gained by repetition under each of the three logics of inquiry introduced in the previous section.

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[39] Rubel, "Epistemology of War Gaming." pp 109-110

[40] Ibid. p 114

[41] Ibid. p 113

[42] Ibid. p 114

[43] Longley Brown, *Successful Professional Wargames: A Practitioner's Guide*. p 114

In considering a more nuanced argument in favor of repetition, I have found it useful not only to consider the philosophical foundations of each game type, but also to draw an analogy to other types of analysis to consider how games are similar (and different) from the logic of other potential approaches to conducting research. In part, relating games to existing approaches provides a common reference point to other, potentially more familiar, approaches to research which have been better documented. This logic also works in reverse—without a deliberate comparison, consumers may incorrectly apply the standards of other methods to games. By exploring why we might want to repeat games, we can help clarify the actual benefits, and how they are different for different types of games.

Positivist

Positivist games use repetition in order to make more observations. This is generally intended to enable the researcher to introduce more variation without losing control over comparisons. Two possible analogies from the traditional tool kit of international relations are available: comparative case studies and experiments. The first focuses on exploring the range of variation. For example, if there are two factors, each with two variations of interest but you can only run two games, you have to accept that the factors will co-vary and be difficult to disentangle. In contrast, if you run four games, it is possible to compare games which are only one factor different to see if decisionmaking changes. The other uses many runs of the game to understand the central tendency of the population under a treatment and control. As a general rule, the former is more common in policy research, and the later in more academic studies of international relations.

In traditional comparative case study analysis, cases are often selected to maximize variation on the key variable of interest while ensuring other variables are as comparable as possible.[44] This suggest that the number of games will be tied directly to the number of variables of interest and their relationships, with one game for each potential combination of variable states. This approach is particularly consistent with research programs that seek to describe causal mechanisms across a small number of variables, creating, in effect a small number of deep cases that can be compared for nuanced differences. However, as with case studies, it is critical to be cautious about over-generalizing the difference observed in these games. For one thing, game designers never have complete control over variation between games because of the key role of players. Thus, like case studies, analysis of repeated alternative conditions games should focus attention on exploring the evidence to support alternative hypotheses before making any type of strong claim from the game series. Because the games are artificial, and thus there is no empirical record of total cases to observe, it is not possible to use medium-n type approaches like

[44] Alexander George and Andrew Bennet, *Case Studies and Theory Development in the Social Sciences* (Boston, MA: MIT Press, 2005).

qualitative comparison analysis[45] in which all possible cases of a class are examined to draw stronger conclusions. Thus, while increasing the number of games can strengthen the evidence for a causal relationship by exploring potential alternative explanations, there will always be limits on what repetition can contribute to the robustness of findings. Put differently, repeated games can allow for more nuanced discussion of how mechanisms work under different conditions, but do less to address generalizability, since the full universe of cases is usually not knowable.

An alternative positivist approach that has become increasingly common in political science research looks to experimental design as a model.[46] This approach shares the basic structure of intentional variation between runs of the game, and often adopts the experimental vocabulary of a "treatment" and "control" condition to describe this variance. In contrast to the case study approach that studies a small number of iterations through deep comparison, experimental approaches seek larger samples of dozens to hundreds of games.[47] Here, repetition is intended to provide an understanding of the central tendency of the population, and so requirements for the number of repetitions are driven by statistical rules. However, often practical limitations, not only in terms of resources but also in terms of access to the population of interest complicate the practicality of this approach. For example, expert and elite communities are often difficult to establish a robust sampling frame, or to make contact with a random, rather than a convenience sample[48]—a problem made worst by the necessity of coordinating multiple subjects to be available for a single, long period of time for game play. As a result, games will generally be more dependent on convenience sampling strategies, making generalization strategies difficult. Current work in international relations seeks to clarify some of these considerations and generate stronger norms in the space.[49]

Critical Realism

Because critical realism is interested in the specific, with the goal of developing, rather than testing hypothesis about causal relationships, repetition is relatively devalued compared to positivist approaches since there is not the focus on comparison. However, there are some potential benefits of repetition under this logic. One, suggested by the description of these games

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[45] Charles C. Ragin, *The Comparitive Method: Moving Beyond Qualitative and Quantitiative Strategies* (Oakland, CA: University of California Press, 2014).

[46] Susan D. Hyde, "Experiments in International Relations: Lab, Survey, and Field," *Annual Review of Political Science* 18 (2015).

[47] Reddie et al., "Next-Generation Wargames: Technology Enables New Research Designs, and More Data."; Jensen and Valeriano, "Cyber Escalation Dynamics: Results from War Game Experiments."

[48] Kenneth Goldstein, "Getting in the Door: Sampling and Completing Elite Interviews," *PS: Political Science & Politics* 35, no. 4 (2002).

[49] Lin-Greenberg, Pauly, and Schneider, "Wargaming for Political Science Research."

as diagnostic,[50] is that multiple games allow for better diagnosis by providing a "second opinion." Of course, since direct observation is impossible under this construct, even if the same hypothesis is suggested multiple times it does not make it right, but in practice, repetition of findings tends to be treated as more credible then a single perspective. A related, but distinct logic argues that repetition is beneficial because it introduces new evidence that supports or refutes the hypothesis. Here, the metaphor of a jury trial, in which different witnesses offer different evidence comes to mind. Again, additional sources of evidence is not proof in the way that direct observation would be, but it adds credibility. Both of these logics suggest that repeated gaming is helpful, but not to the same degree, or with the same clarity about how many repetitions are needed as in the positivist case. While in the long run, this suggests an area ripe for more research, in the short term, these metaphors may help drive a more informed conversation with funders of the relative value of the additional credibility gained through repetition.

Analyticism

Games in the analyticist philosophical framework are repeated to add more viewpoints, and thus build a more comprehensive understanding of the problem. In my experience, this process is analogous to conducting expert interviews to synthesize expert technical and process knowledge or generate "a theoretically rich conceptualization of (often implicit, yet reconstructible) knowledge, conceptions of the world and routines, which the experts and elites develop in their activities and which are constitutive for the functioning of social systems."[51] Put differently, analyticist games and expert interviews often share the goal of building a model of a particular phenomenon that is informed by the explicit and tacit knowledge of specialists in the domain.

Following that analogy, we can look to the literature on number of interviews as a guide to repeating games. While the ideal number of interviews is not fixed in the literature, a common standard employed is that of "saturation"—that is "you keep asking as long as you are getting different answers, and that is a reminder that with our little samples we can't establish frequencies but we should be able to find the RANGE of responses."[52] As you interview more people, you gain an understanding of what parts of their understanding are shared as well as some insights about what might be driving differences. At some point, the marginal returns of conducting more interviews is minimal because you've already captured the vast majority of how experts see the problem. Practically, when each interview contributes little to no additional

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[50] Compton, "Analytical Gaming."

[51] Alexander Bogner, Beate Littig, and Wolfgang Menz, "Generating Qualitative Data with Experts and Elites," in *The Sage Handbook of Qualitative Data Collecation*, ed. Uwe Flick (London, UK: SAGE Publications Ltd, 2018). P 10

[52] Harry Wolcott, quoted in Sarah Elsie Baker and Rosalind Edwards, "Introduction," in *How Many Qualitative Interviews Is Enough? Expert Voices and Early Career Reflections on Sampling and Cases in Qualitative Research*, ed. Sarah Elsie Baker and Rosalind Edwards (National Centre of Research Methods, 2012). p 4

information to the researcher, saturation has been reached. So too with analyticist games—additional runs of the game allow you to speak to new experts and watch different combinations of experts interact with one another, until the model built in the game is fairly stable.

This "saturation" approach offers useful guidance, but also some clear pitfalls for a researcher. A commonly cited issue with this approach is that it requires "the researcher to combine sampling, data collection, and data analysis, rather than treating them as separate stages in a linear process."[53] One implication of this is that it is difficult, if not impossible for a researcher to anticipate how many interviews will be needed for saturation to occur in advance. Given the cost and time involved in each run of the game, this level of uncertainty poses a concern for a researcher planning out a campaign of games-based research. Existing interview work stresses that the degree to which full saturation is necessary will depend on the research question and community norms[54]--developing these norms more fully and coherently within the gaming community is thus likely to be required before clear guidance is evident.

However, as an initial proposition, depending on the nature of the research topic and the initial game's make-up of players, relatively few or even no repetitions of the game may be valuable. In part this is because a game, by dint of bring together groups of participants, already offers a range of perspectives in comparison to single subject interviews. If the purpose of the game is to scope follow on research, and the 80% solution is enough to inform next steps, then expensive additional iterations to get to 100% saturation may well not be a cost-effective use of a limited research budget. For more poorly understood or complex problems, repetition may be an important way of building understanding. However, after several repetitions, designers often find it productive to change the focus of the game significantly enough that they are no longer using the same design (an approach discussed in more detail later in this chapter). As a result, it is unusual to see the same game played more then a handful of times under analyticism.

The Value of Games in Multi-Method Research

Both practitioner policy analysts and political science share a belief that research that leverages multiple tools and approaches generates more credible results. However, to date the practitioner community has under-articulated both the value of such research plans and how they can best be constructed. At the same time, works on multi-method research in social science have not included gaming in their considerations. Considering games in light of the more developed political science literature on multi-method research offers richer advice for how games can be leveraged in such studies.

[53]Alan Bryman quoted in ibid. p 5

[54] Ibid. pp 5-6

Generally, when defense policy practitioners discuss using gaming in conjunction with other tools, they refer to the "cycle of research,"[55] illustrated in Figure 1, which argues that games should be linked to analysis and exercises. Though Perla makes it quite clear that the cycle of research can move in different sequences depending on the research questions at hand, discussion is dominated by a specific sequence exemplified by the historical example of naval innovation in the interwar years.[56] This canonical process argues that gaming should be used at the start of research for exploration and idea generation, followed by operations research analysis, most often campaign analysis using computerized modeling and simulation, to refine the approach with higher precision analysis, followed by field exercises to test how the ideas work in practice. The dominance of this model has not only calcified this particular sequence of tools, it also sets expectations that efforts to incorporate multiple tools require multi-year projects that involve multiple analytic offices—a scale simply not achievable for most analytic efforts. Thus, while the "cycle of research" is held up as an ideal, existing texts do not support researchers in thinking critically about what tools will combine to produce more credible findings, at a realistic scale.[57]
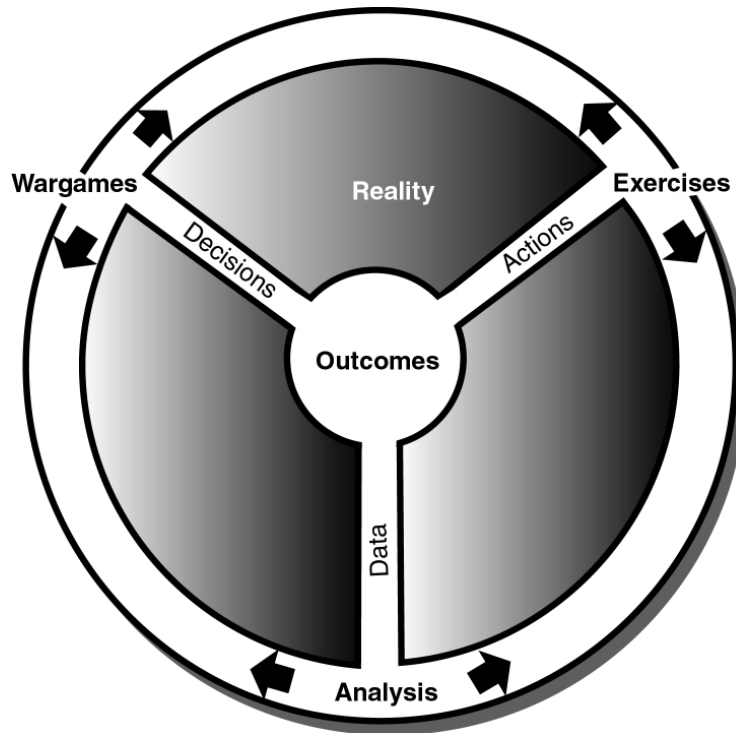
This gap is particularly ironic, because developing and analyzing a game often requires that a researcher leverage multiple means of gathering and analyzing evidence. All games, regardless of type, require research in the pre-play stages in order to develop a model of the policy problem for players to interact with. Interviews, comparative case studies, and formal modeling are all common tools used to develop the game. Data generated by the game must also be analyzed, which can take a wide range of forms including but not limited to qualitative coding, process tracing, text analysis, social network analysis, and regressions, depending on the information the game generates. How such approaches are selected and connected to one another is rarely discussed, and in practice is often a matter of the skills and data collection tools known by the project team. Again, a general, systematic framework is lacking.

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[55] Perla, *The Art of War Gaming: A Guide for Professionals and Hobbyists*; Peter Perla et al., "Rolling the Iron Dice: From Analytical Wargaming to the Cycle of Research," *War on the Rocks*, October 21, 2019 2019; Phillip E Pournelle, "Can the Cycle of Research Save American Military Strategy?," ibid.

[56] For a high level example of how this model is evoked, see: Work and Selva, "Revitalizing Wargaming Is Necessary to Be Prepared for Future Wars."

[57] Jon Compton, "The Obstacles on the Road to Better Analytical Wargaming," ibid.2019.

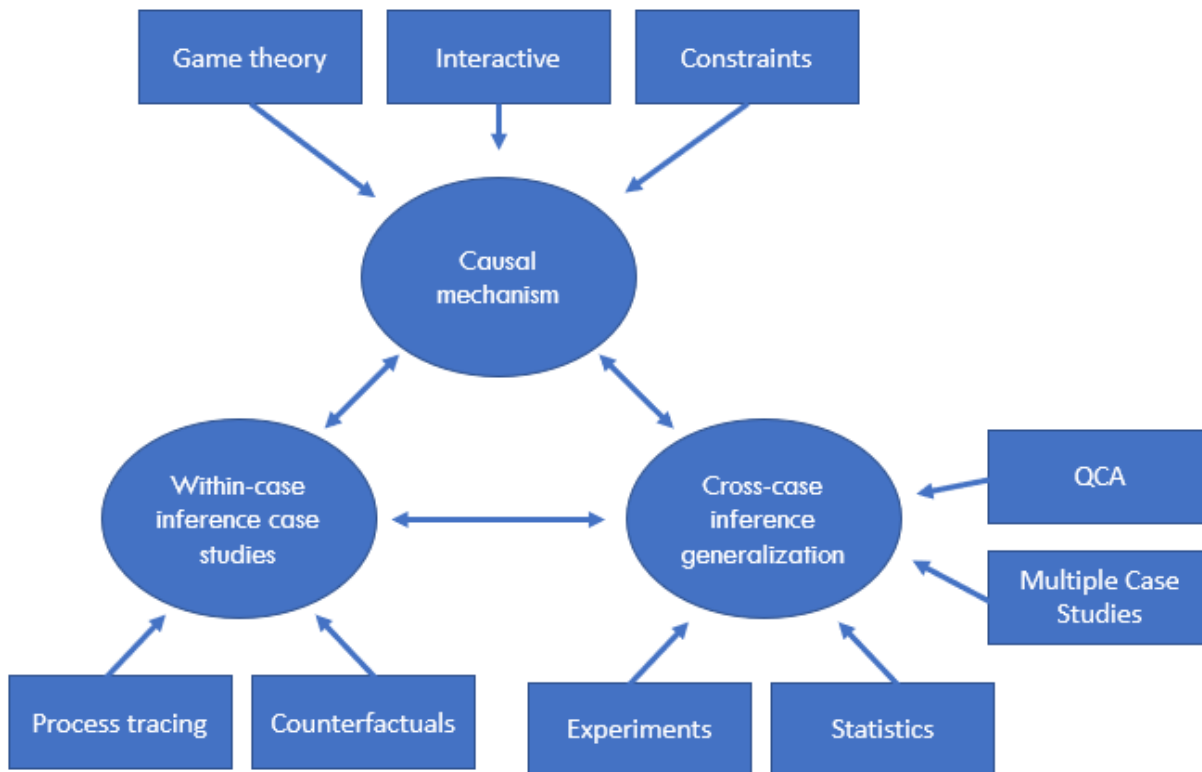**Figure 1: Perla's Cycle of Research**

Source: Peter P. Perla, *The Art of War Gaming: A Guide for Professionals and Hobbyists*, ed. John Curry, 2nd ed. (History of Wargaming Project, 2011).

In contrast, political scientists have spent considerably effort conceptualizing the value and practice of multi-method projects. Critically, recent work shifts attention from the number or kind of tools used to the question that is being asked at each stage in research. Gary Goertz offers a particular clear division of different approaches into three broad categories, illustrated in Figure 2: tools to articulate causal mechanisms, tools to explore a specific empirical incident in depth, and tools to explore cause and effect across many cases to understand general behavior. The first group of approaches focus on formal modeling—that is conceptual or mathematical arguments that lay out a concept of how a cause achieves a particular effect. The second is exemplified by case study research that deeply considers a single empirical case to advance an argument about what happened and why. Third are tools that look across multiple cases to establish trends about general behavior. In Goertz's view, work that tries to balance these three perspectives in invested in a multi-method approach.[58]

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[58] Gary Goertz, *Multimethod Research, Causal Mechanisms, and Case Studies: An Integrated Approach* (Princeton, NJ: Princeton University Press, 2017). pp 1-5

Figure 2: Goertz's Research Triad

Source: Gary Goertz, *Multimethod Research, Causal Mechanisms, and Case Studies: An Integrated Approach* (Princeton, NJ: Princeton University Press, 2017 p 2

This approach is helpful in that it moves the debate away from specific historical examples or existing skill sets towards fundamental questions about what types of work the study aims to do. Studies that only need to propose a new model, explain a single case, or describe cross cutting trends need not venture into multi-method work. Projects that seek to answer questions that require elements of all of these will require a broader approach.

Within social science work, there are a few typical ways of leveraging the triad. The first is the use of broad cross-case analysis to identify general trends, followed by deeper analysis of a specific case identified from the broader analysis that is used to generate a causal mechanism model. Another common approach is the generation of a causal model from a single case, which is then expanded into cross-case studies to ensure that the causal mechanism is, in fact, widespread. Both general pathways can be populated by different collections of tools, but all are designed to deal with causal arguments that are more complex then X treatment generates Y effect. This can include causal narrative in which a series of factors must be present one after another and in which different factors interact with one another in key ways. Given the complexity and contingencies we tend to associate with group decisionmaking about complex

policy decisions, such multi-factor causal arguments are more likely than not to be occurring in policy contexts.[59]

So where do games fit into this triad? Comparing the tools and approaches analogized to gaming earlier in this article to Goetz's triad at even a superficial level suggest that there is more than one possible purpose for gaming, which means that not all games will serve the same function in the triad. The follow sections discuss the ability of games to function in each of the three roles of multi-method research, demonstrating that each of Goertz's modes fits well with one of the logics of inquiry identified above. Thus, I argue that analyticism games tend to be used to define causal mechanism, critical realist games to offer a within case study, and positivist work to look across cases.

That games can be used in all three of these modes means that in addition to games working in conjunction with other approaches, there is an opportunity to use games in different ways over the course of a study. In cases where more then one type of game is used, we tend to describe the study as using a series of games, whereas when games are paired with other approaches, then the label multi-method is more likely to be used. However, fundamentally the process of selecting tools that are well suited to each task of the triad is the same regardless of what portion of the selected approaches turn out to be games—as a result, no distinction is made in the discussion below.

Analyticist Games as Causal Mechanism

The first leg of the triad focuses on laying out a model of a specific causal mechanism. Fundamentally, the task can be thought of as drawing figures showing the links between independent variables, mechanisms, and dependent variables.[60] One particularly common approach is to describe mechanisms as pathways from cause to effect,[61] recognizing that most social processes are sufficiently complex that they will generally require more than one step[62] and may consist of interacting necessary and sufficient elements.[63]

When used in this leg of the triad, games can be thought of as an approach to build and document a mechanistic model. This aligns particularly well with games run under an analyticist framework, since this mode of games seeks to produce models that describe the elements and relationships between different parts of a policy problem. The resulting model meets the bar for usefulness so long as it can clearly articulate mechanisms, but the game does not provide an

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[59] Ibid. pp 6-13

[60] Ibid. p 33

[61] John Gerring, "The Mechanism Worldview: Thinking inside the Box," *British Journal of Political Science* 388 (2008).p 178

[62] Goertz, *Multimethod Research, Causal Mechanisms, and Case Studies: An Integrated Approach*. p 36

[63] Ibid. p 42

empirical check on findings or any generalizability without being linked to work in the other two corners of the triad.

In this approach, games are most often used early in the study design, then followed by other approaches to provide evidence about whether behavior seen in the game is representative of real-world behavior, or if the artificialities of the game have suggested a causal mechanism that seems sound in theory but is not evidenced in practice. Games of this type make tradeoffs that simplify many aspects of the world in order to illuminate others. Players are often not the same as decision-makers, aspects of the environment are not included in the game's scenario, and layers of bureaucracy are stripped away. In other words, the game cannot simulate everything about the real world and these simplifications could change the findings. As a result, it is critical to ask how simplifications affected the key results of the game, and how the mechanism might be complicated once applied in real-world contexts.

Since games are frequently used when compelling empirical observation from past or present events is not easily available, gather evidence to populate the other two legs of the triad may not be trivial. One way to conceptualize the value of games in such combinations is that using a game to develop robust causal mechanisms can help make the most of the limited available data from more traditional empirical approaches. For example, games have been used to fill in gaps in historical accounts of battles[64]—taking the empirical case as a starting point, the game is developed to posit mechanisms that logically connect the limited data that is available. Alternatively, causal mechanism games may be used first to develop a robust theory that can help identify reasonable proxies for unobserved (or unobservable) phenomenon. No empirical evidence will be available about how a war will be fought 10 years in the future, but clarifying key capabilities needed to see an outcome may help focus attention on studying emerging technology and doctrine whose current development will shape future conflict. Another option is to treat historical data as something of a sanity check. For example, pairing game results with a historical case study of a similar type of decision could provide a robustness check of whether the mechanisms proposed by the game in a future environment are credible given past bureaucratic behavior. Put simply, the game's exploration of causal mechanisms becomes an aid for how to make the most of limited empirical data in the other two corners of the triad.

Another option available to researchers is to use gaming in more than one role in the triad. Many large gaming studies will first run a "playtest" or "beta test" of the game to receive feedback. This stage of research is generally discussed as an element of games design best practices,[65] rather than being treated as an key element of research in its own right, but the process of playing the game with the goal of improving the game design is, in fact, an important effort to examine and improve the formal model of the game. This work ensures that necessary

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[64] Philip A. G. Sabin, *Lost Battles: Reconstructing the Great Clashes of the Ancient World* (London, UK: Bloomsbury Academic, 2015).

[65] Perla, *The Art of War Gaming: A Guide for Professionals and Hobbyists*. pp 218-219

mechanisms are included in game play, potential alternative causal narratives are considered, and that extraneous elements are not included in the interest of parsimony. This work helps to ensure that the empirical data that is collected in later runs of the game is as salient as possible.

Critical Realist Games for Within-Case Inference

The second leg of the triad focuses on the use of a single case to provide an empirical evidence of a causal mechanism. Generally, selection of a single case focuses on a case that is believed to be a good example of the causal mechanism of interest,[66] which can allow for close study of how the posited mechanisms play out in practice. In older works on case study selection this is thought of as a "most likely" case for the phenomena of interest to occur.[67] In other words, the within case study selects one of the possible cases that would be studied in the cross-case leg of the triad and uses it to refine the formal model developed in the third leg. The case can also be used as a ground to "soak and poke" in order to develop hypothesis to be captured in a formal model.

The use of games in this corner of the triad is effectively a type of synthetic case study. Given the analytic preference and relative accessibility of traditional case studies, games are likely to only be used as cases when real-world observations are not available or are impractical. In effect, the researcher is using the game as a source for rich data as a substitute for historical materials. Game observations about the decision-making process of players can then be subject to the same kinds of process tracing and counterfactual analysis as would be conducted on traditional historical data, with the necessary caveats and limitations to account for the artificialities of the game environment.

Here, the within case game generally falls relatively early in study. In some cases, it may be the first tool used as a means of providing a foundation for later theory development. For example, a new research team might use a game to explore a novel problem, and then use that shared experience to develop a model using traditional formal approaches. Alternatively, theorizing may come first (either using a game as discussed above or another formal approach) which is then refined by collecting rich data about how key mechanisms play out in a game. Finally, while it is possible for cross-case comparison work to occur first, that is likely to occur only in cases in which there is sufficient data to allow a population of cases to be defined and typed, but not sufficient to enable historical case study analysis, making this approach relatively uncommon.

Positivist Games for Cross-Case Inference

The final leg of the triad explores how the causal mechanisms generalize across a range of cases. Fundamental to this task is the definition of the scope of cases where we would expect the

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[66] Goertz, *Multimethod Research, Causal Mechanisms, and Case Studies: An Integrated Approach*. pp 63-66

[67] George and Bennet, *Case Studies and Theory Development in the Social Sciences*.

causal mechanism to apply. This allows confirmation (or lack thereof) of the generalizability of the causal mechanism and requires consideration of cases that could falsify or complicate the posited mechanism by exploring confounding factors or adjusting scope.[68] While these approaches are most closely associated with experimental and quantitative approaches, cross-case comparison approaches also fit in this model.

As with within-case inference, games for cross case inference operate as synthetic cases to produce empirical evidence but the approach is expanded to multiple games to allow comparison. As discussed in the introduction to positivist games above, two general approaches to cross case comparison are seen with games—the first which focuses on a relatively small number of cases in sufficient depth to study variation in causal mechanisms, and a second which seeks to use a larger number of games to observe average differences in behavior over the population, often through an experimental construct. Which approach is appropriate will likely depend on the nature of the question under study. More complex causal mechanisms will tend to require richer data to meaningfully explore, where-as more narrowly scoped problems will be more tractable to experimental designs.

While successful studies can certainly start with cross-case companions, this may be less likely when it comes to games. Running any sizable number of games is time consuming and expensive—doing so as a means of initially scoping the problem will not often be practical. In part, this is because the synthetic nature of games means that the designer is free to manufacture a very wide range of potential cases indeed—without the focus provided by previous research into causal mechanisms, such efforts are likely to be scattershot. Far more common is the use of cross case comparison games after mechanisms have been formalized, at minimum through the use of a playtest game, and thus the selection of game cases can be minimized to the extent possible.
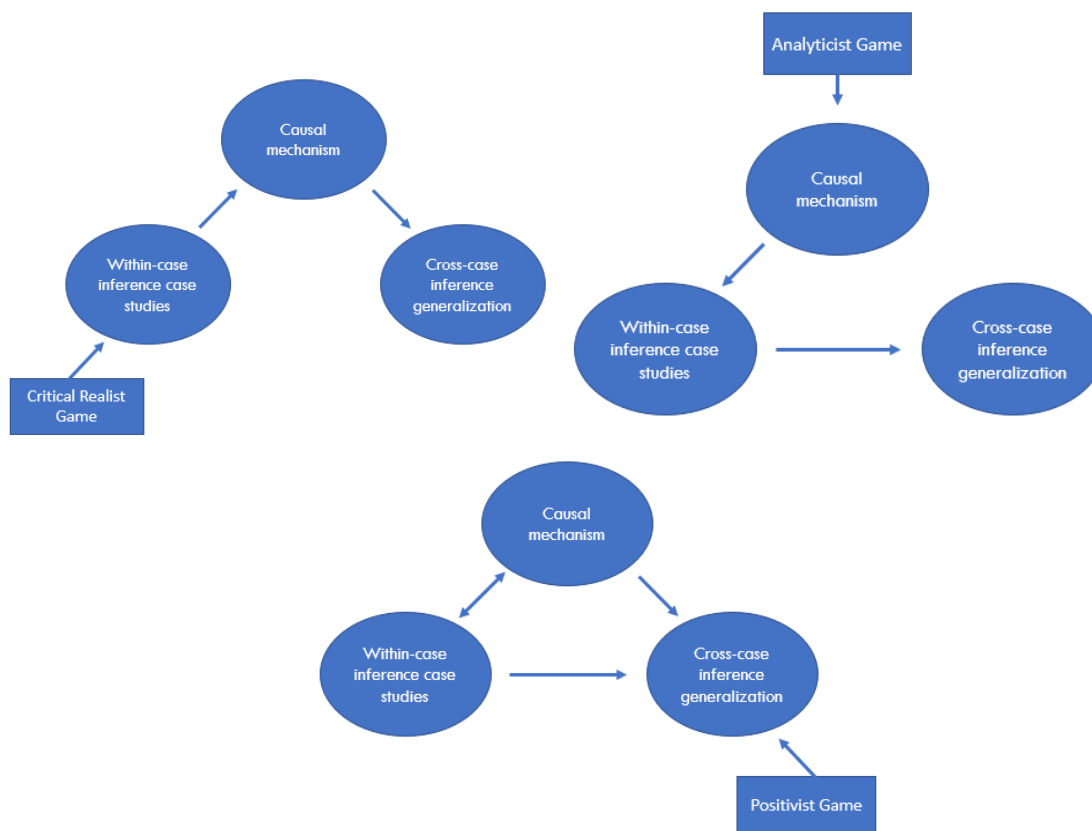
Generalize Study Models Using Games

Taken together, these arguments suggest the viability of games in all three corners of Goertz's triad, but also suggest that some sequences of tools are more likely than others. Figure 3 suggest three likely patterns, two starting with games, and one ending with them. While in theory, the other two corners of the triad could use any of the techniques Goetz discusses, in practice, the use of games suggests that available data may constrain the options available to a research, particularly for within case and cross case analysis. This may tend to encourage the use of games in more then one step of the triad within the same analysis. While this is not methodologically problematic (in fact as the discussion regarding playtesting above suggests it is likely done far more then is recognized today), it does suggest the need for researchers to be more clear about what work a game is doing at different stages of analysis. In particular, since

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[68] Goertz, *Multimethod Research, Causal Mechanisms, and Case Studies: An Integrated Approach*. pp 60-61, pp 66-71

gaming at different steps of the triad is linked to different philosophies of inquiry, clarity to ensure that the conclusions of the game are framed in a way that is appropriate to the logic being used at the moment is critical. In particular, the switch from treating games as a model in the analyticist lens to an empirical data generation tool under critical realism and positivist frames may be particular challenging, both for the research team and for the consumers of games-based research. Better standards for managing this transition are likely needed to improve the credibility of research done in this mode.

Figure 3: Options for integrating games into multimethod studies

Conclusions

Policy researchers have long touted the benefits of multiple runs of games and games combined with other methods, but historically have not articulated how repetition and multi-methods approaches contribute to stronger findings beyond the invocation of historical examples. In contrast, discussion of research methods in international relations has devoted considerable time to research design but has not historically included games as part of this discussion. This paper brings the two communities into dialog, by exploring the range of games commonly

discussed in policy analysts using the vocabulary and concepts from academic international relations. This crosswalk reveals that games can be analogized to multiple traditional research tools, depending on how they are used. While this prevents one-size fits all guidance about how games should be incorporated into broader studies, it illustrates the diversity of ways games can be used alongside more traditional methods. My hope is that this effort contributes to ongoing attempts to better leverage games by allowing scholars to construct more robust studies and communicate those efforts in ways that are more legible to the broader IR community.

References

Asal, Victor. "Playing Games with International Relations." *International Studies Perspectives* 6, no. 3 (2005): 359-73.

Baker, Sarah Elsie, and Rosalind Edwards. "Introduction." In *How Many Qualitative Interviews Is Enough? Expert Voices and Early Career Reflections on Sampling and Cases in Qualitative Research*, edited by Sarah Elsie Baker and Rosalind Edwards: National Centre of Research Methods, 2012.

Bartels, Elizabeth M. "Building Better Games for National Security Policy Analysis: Towards a Social Scientific Understanding." Pardee RAND Graduate School, 2020.

Bartels, Elizabeth M., Igor Mikolic-Torreira, Steven W. Popper, and Joel B. Predd. "Do Differing Analyses Change the Decision?: Using a Game to Assess Whether Differing Analytic Approaches Improve Decisionmaking." Santa Monica, CA: RAND Corporation, 2019.

Barzashka, Ivanka. "Wargaming: How to Turn Vogue into Science." *Bulletin of the Atomic Scientists*, 2019.

Beach, Derek, and Rasmus Brun Pedersen. *Causal Case Study Methods: Foundations and Guidelines for Comparing, Matching, and Tracing.* Ann Arbor, MI: University of Michigan Press, 2016.

Bogner, Alexander, Beate Littig, and Wolfgang Menz. "Generating Qualitative Data with Experts and Elites." In *The Sage Handbook of Qualitative Data Collecation*, edited by Uwe Flick, 652-65. London, UK: SAGE Publications Ltd, 2018.

Caffrey, Matthew B. *On Wargaming: How Wargames Have Shaped History and How They May Shape the Future.* Newport, RI: Naval War College Press, 2019.

Compton, Jon. "Analytical Gaming." 2014.

———. "The Obstacles on the Road to Better Analytical Wargaming." *War on the Rocks*, 2019.

Elias, George Skaff, Richard Garfield, and K. Robert Gutschera. *Characteristics of Games.* Cambridge MA: MIT Press, 2012.

Frank, Aaron. "The Philosophy of Science and Intelligence: Rethinking Science in Support of Intelligence." In *International Studies Association Annual Conference*. San Diego, CA, 2012.

Geoffrey, Engelstein., and Issac Shalev. *Building Blocks of Tabletop Game Design: An Encyclopedia of Mechanisms.* Boca Raton, FL: CRC Press, 2019.

George, Alexander, and Andrew Bennet. *Case Studies and Theory Development in the Social Sciences.* Boston, MA: MIT Press, 2005.

Gerring, John. "The Mechanism Worldview: Thinking inside the Box." *British Journal of Political Science* 388 (2008): 161-79.

Goertz, Gary. *Multimethod Research, Causal Mechanisms, and Case Studies: An Integrated Approach.* Princeton, NJ: Princeton University Press, 2017.

Goldstein, Kenneth. "Getting in the Door: Sampling and Completing Elite Interviews." *PS: Political Science & Politics* 35, no. 4 (2002): 669-72.

Hyde, Susan D. "Experiments in International Relations: Lab, Survey, and Field." *Annual Review of Political Science* 18 (2015): 403-24.

Jackson, Patrick Thaddeus. "The Conduct of Inquiry in International Relations: Philosophy of Science and Its Implications for the Study of World Politics." New York, NY: Routledge, 2011.

Jensen, Benjamin, and Brandon Valeriano. "Cyber Escalation Dynamics: Results from War Game Experiments." In *International Studies Association*. Toronto, Canada, 2019.

Johnson, Dominic D. P., Rose McDermott, Emily S. Barrett, Jonathan Cowden, Richard Wrangham, Matthew H. McIntyre, and Stephen Peter Rosen. "Overconfidence in Wargames: Experimental Evidence on Expectations, Aggression, Gender, and Testosterone." *Proceedings of the Royal Society* 273 (2006): 2513-20.

Judge, Sawyer. "The Wargaming Guild: How the Nature of a Disipline Impacts Its Craft and Whether It Matters." Georgetown University, 2019.

Levine, Robert A., Thomas C. Schelling, and William M. Jones. "Crisis Games 27 Years Later : Plus C'est Deja Vu." Santa Monica, CA: RAND Corporation, 1991.

Lin-Greenberg, Erik. "Game of Drones: What Experimental Wargames Reveal About Drones and Escalation." *War on the Rocks*, 2019.

———. "(War)Game of Drones: Remote Warfighting Technology and Escalation Control Evidence from Wargames." SSRN, 2019.

Lin-Greenberg, Erik, Reid B.C. Pauly, and Jacquelyn Schneider. "Wargaming for Political Science Research." In *APAS Annual Conference*. Virtual, 2020.

Longley Brown, Graham. *Successful Professional Wargames: A Practitioner's Guide.* Edited by John Curry. The History of Wargaming Project, 2019.

Lourie, Megan, and Elizanth Rata. "Using a Realist Methodology in Policy Analysis." *Education Philosophy and Theory* 49, no. 1 (2017): 17-30.

McEvoy, Phil, and David Richards. "Critical Realism: A Way Forward for Evaluation Research in Nursing?". *Journal of advanced Nursing* 43, no. 4 (2003).

Parson, Edward. "What Can You Learn from a Game?". In *Wise Choices: Decisions, Games, and Negotiations*, edited by Ralpj L. Keeney Richard J. Zeckhauser, James K. Sebenius, 233-52. Boston: Harvard Business School Press, 1996.

Pauly, Reid B.C. "Would U.S. Leaders Push the Button? Wargames and the Sources of Nuclear Restraint." *International Security* 43, no. 2 (2018): 151-92.

Perla, Peter , Michael Markowitz, and Christopher Weuve. "Game-Based Experimentation for Research in Command and Control and Shared Situational Awareness." Alexandria, VA: CNA, 2005.

Perla, Peter, Web Ewell, Christopher Ma, Justin Peachey, Jeremy Sepinsky, and Basil Tripsas. "Rolling the Iron Dice: From Analytical Wargaming to the Cycle of Research." *War on the Rocks*, October 21, 2019 2019.

Perla, Peter, Michael Markowitz, and Christopher Weuve. "Game-Based Experimentation for Research in Command and Control and Shared Situational Awareness." Alexandria, VA: Center for Naval Analyses, 2002.

Perla, Peter P. *The Art of War Gaming: A Guide for Professionals and Hobbyists.* Edited by John Curry. 2nd ed.: History of Wargaming Project, 2011.

Pettyjohn, Stacie, and Becca Wasser. "The Promise of Structured Strategic Wargames: Moving Beyond the Seminiar." In *International Studies Association*. San Francisco, 2018.

Pournelle, Phillip E. "Can the Cycle of Research Save American Military Strategy?" *War on the Rocks*, 2019.

Ragin, Charles C. *The Comparitive Method: Moving Beyond Qualitative and Quantitiative Strategies.* Oakland, CA: University of California Press, 2014.

Reddie, Andrew W., Bethany L. Goldblum, Kiran Lakkaraju, Jason Reinhardt, Michael Nacht, and Laura Eipifanovskaya. "Next-Generation Wargames: Technology Enables New Research Designs, and More Data." *Science* 362, no. 6421 (2018): 1362-64.

Rubel, Robert C. "Epistemology of War Gaming." *Naval War College Review* 59, no. 2 (2006): 108-28.

Sabin, Philip A. G. *Lost Battels: Reconstructing the Great Clashes of the Ancient World.* London, UK: Bloomsbury Academic, 2015.

Schneider, Jacquelyn G. "Cyber Attacks on Critical Infrastructure: Insights from War Gaming." *War on the Rocks*, July 26 2017.

Tekinbas, Katie Salen, and Eric Zimmerman. *Rules of Play: Game Design Fundamentals.* Cambridge MA: MIT Press, 2003.

Work, Robert, and Paul Selva. "Revitalizing Wargaming Is Necessary to Be Prepared for Future Wars." *War on the Rocks*, December 8 2015.