"The Science of Wargames: A discussion of philosophies of science for research games"

Elizabeth M. Bartels, Pardee RAND Graduate School

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What and how do we learn from games designed to support research and analysis? Surprisingly, this is not a settled question among policy gaming practitioners. A debate has raged over whether game can best be considered an art or a science, and what that might mean for what types of conclusions can be drawn from games.[1] Advocates for seeing games as "art" emphasize the experience of the participants of a game, and how games have the ability to cultivate new thoughts and build new understanding in the minds of players.[2] Defenders of the position that games are a science argue that, if games are going to contribute to analytic projects, they should be held to the same standards as other types of research.[3] While both positions are represented among professional gamers, based on analysis of a recent survey of gamers, those using artistic language and design principles like "player enjoyment" outnumber the supporters of viewing games from a scientific perspective.[4]

The commitment to treating policy gaming as an art comes with costs. United States Department of Defense officials have stated that greater systemization of gaming is necessary for games to have their desired impact on policy.[5] Spend time at a gathering of gamers and it is normal to hear concerns that the results of games are warped or dismissed by sponsors and stakeholders,[6] and that inexperienced gamers are developing unsound products.[7] At the same

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[1] Peter P. Perla, "The Art and Science of Wargaming to Innovate and Educated in an Era of Strategic Competition," in *King's College London Wargaming Network Lecture* (London, UK2018).

[2] Peter P. Perla and ED McGrady, "Why Wargaming Works," *Naval War College Review* 64, no. 3 (2011).

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

[4] Elizabeth M Bartels, "Insights from a Survey of the Wargaming Community," in *Military Operations Research Society Wargaming Community of Practice* (Alexandria, VA2017).

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

[6] Stephen Downes-Martin, "Your Boss, Players and Sponsor: The Three Witches of War Gaming," *Naval War College Review* 67, no. 1 (2014).

[7] Stacie L. Pettyjohn and David A. Shlapak, "Gaming the System: Obstacles to Reinvigorating Defense Wargaming," *War on the Rocks*, February 18, 2016 2016.

time, newer gamers argue there are not sufficient tools to learn their trade.[8] Without the discipline of science, too often games fail to meaningfully inform what we know about the world in credible ways.

So why is there so much resistance to viewing games as a scientific approach? Ivanka Barzashka's recent article in the *Bulletin of the Atomic Scientists* calling for a more scientific approach to gaming makes several important points.[9] Most critically, many gamers have a narrow understanding of how science is practiced. Many gamers are strongly influenced by military operations research[10] and associated engineering approaches. These approaches tend to define science in quantitative terms, featuring "definite methodologies of attacking new problems and finding definite solutions."[11] Unsurprisingly, this approach to science is a poor fit with the human-centric, exploratory nature of games, and gamers resent the attempt to demarcate their field as "unscientific" and thus less valuable.

However, some members of the gaming community have argued that there are alternative forms of scientific practice available to gamers which offer different demarcations about what is scientific that may better accommodate the nature of gaming. For example, recent work by Yuna Wong has situated gaming in a broader history of "soft" operations research.[12] Other recent work by scholars and practitioners like Compton,[13] McCown,[14] Bartels,[15] and Barzashka[16] has pointed to different models with in the social sciences as a potential source. These works suggest the potential value of a broader exploration of science and how gaming might fit its paradigms.

A cursory survey of the philosophy of science literature quickly reveals greater diversity of thought then the standard "scientific method". Limiting our consideration only to major debates within the 20th century, we do find our "standard" description of science as a systematic process to falsify broad law-like claims.[17] However, we also find major figures arguing that this approach

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[8] Elizabeth M Bartels, "Building a Pipeline of Wargaming Talent: A Two-Track Solution," ibid.2018.

[9] Barzashka, "Wargaming: How to Turn Vogue into Science."

[10] It is perhaps worth noting that there are alternatives to this vision of operations research, particularly in older texts, that is still practice, particularly in the UK. For a discussion of alternative approaches to operations research, and their relationship to gaming, please see: Yuna Wong, "Preparting for Contemporary Analytic Challenges," *Phalanx* 47, no. 4 (2014).

[11] Philip M. Morse and George E Kimball, *Methods of Operations Research*, 3rd ed. (Mineola, NY: Dover Publications, Inc, 2003).

[12] Wong, "Preparting for Contemporary Analytic Challenges."

[13] Jon Compton, "Analytical Gaming," (2014).

[14] Elizabeth M. Bartels, Margaret McCown, and Timothy Wilkie, "Designing Peace and Conflict Exercises: Level of Analysis, Scenario, and Role Specification," *Simulation & Gaming* 44, no. 1 (2013).

[15] Elizabeth M. Bartels, "Games as Structured Comparisons: A Discussion of Methods," in *International Studies Association* (San Francisco, CA2018).

[16] 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).

[17] Karl Popper, *The Logic of Scientific Discovery* (New York, NY: Routledge, 1992). p 92

is rarely used in practice, instead arguing that "normal" science as practiced in most day to day research instead focuses on solving puzzles that operate within the constraints of major theories.[18] Rather than falsify theories, evidence that counters existing principles are interpreted carefully within the confines of major theories making truly disruptive work "extraordenary." Other major figures argue for moving away from the individual theory to instead consider "research programmes" of interrelated claims, which can be examined retroactively to see if they are progressing or degenerating over time and across debates.[19] Taken together, these perspectives reinforce that there is more than one way available to do science.

Based on this diversity of available approaches, gamers may need to look more comprehensively to find an appropriate approach to model. To paraphrase a scholar of intelligence analysis engaged in a similar debate: "rather than ask whether intelligence analysis [or in our case, gaming] is an art or a science, more productive answers will come from asking what kind of science [gaming] is or could be?"[20]

This article attempts to answer this question in several steps. First, I briefly summarize an existing synthesis of different philosophies of science to provide a point of departure. I then consider existing work on gaming and identify evidence of three different philosophies underpinning work by different gamers. In the second section, I consider how a commitment to one of the three philosophies might shape what type of knowledge can be produced by games and how it is generated. Finally, I argue that different philosophies tend to align best with games designed to produce different types of information. Taken together, this work suggests that a commitment to different philosophies of science will tend to produce different types of games. Most designers have a natural inclination toward particular philosophical commitments. If designers opt to work on games that relay on a different philosophy's underpinnings, the designer must be highly conscious to adopt what types of claims are made to align with the choice of philosophy.

Philosophies of Science for Gaming

In attempting a short consideration of a philosophy of science of gaming, it is helpful to refer to the treatment of the topic in international relations literature. The similarities of topic between international relations scholarship and national security policy games makes this a natural bridge point into more academic literatures. The eclectic intellectual traditions and substantive concerns in this field also make for a rich discussion of different philosophy of science considerations and concerns.

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[18] Thomas Kuhn, *The Structure of Scientific Revolution* (Chicago, IL: University of Chicago Press, 1970).

[19] Imre Lakatos, "History of Science and Its Rational Reconstructions," in *The Methodology of Scientific Research Programmes*, ed. John Worrall and Gregory Currie (Cambridge, UK: Cambridge University Press, 1978).

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

Jackson's Typology of Philosophies of Science

Patrick Thaddeus Jackson has a particular coherent framework summarizing alternative perspectives on the grounds for making claims in international relations.[21] Jackson distinguishes two major "wagers" that when intersected define four major traditions. On one hand he is concerned with the situation of the researcher in relation to the world, distinguishing between traditions that see the mind as separate, and therefor able to objectively view events (formally "mind-world dualism"), from perspectives that see the observer as inherently a part of the world, and thus observation as subjective ("mind-world monism"). On the other hand, he distinguishes between traditions that believe in generating knowledge based on observation alone ("phenomenalism") from those that argue we can learn about the unobservable ("transfactualism"). When intersected these principles characterize four distinct philosophy of science traditions--neopositivism, critical realism, analyticism, and reflexivity--illustrated in Figure 1.[22]

Figure 1: Jackson's typology of philosophies of science

	Phenomenalism	Transfactualism
Mind-world Dualism	**Neopositivism**	**Critical Realism**
Mind-world Monism	**Analyticism**	**Reflexivity**

Source: Jackson, p 37

Each of the types Jackson lays out captures a particular philosophical position that has been used to generate knowledge in international relations. Below I summarize key discussion of neopositivism, critical realism, and analyticism as the three approaches most relevant to the empirical interest of policy.

Neopositivism

The most common of the positions is neopositivism. Neopositivists are interested in understanding whether general, law-like statements about causality between discreet factors can

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[21] I also owe thanks to conversations with several scholars for early formulations of this discussion, most notably Tony Rivera, San Francisco, March 2018 and Jacqueline Schneider, Toronto, March 2019.

[22] Jackson, "The Conduct of Inquiry in International Relations: Philosophy of Science and Its Implications for the Study of World Politics." pp 34-39

correctly describe observed patterns.[23] 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.[24] Importantly, Jackson highlights the space in this tradition for qualitative evidence, and modes of analysis that focus on intervening mechanism, making for a much broader tent then the narrow perspective sometimes ascribed to this approach.[25] While Jackson's work notes the dominance this group of approaches within academic settings, its 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.

Critical Realism

In contrast to the neopositivist 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 evidence available changes, the causal theory may evolve, however the theory is still fundamentally unproven by this process—abduction cannot demonstrate truth, only plausibility.[26] This approach moves away from the normal scientific assumption of generalizability, to focus instead on building an understanding of the "specific, contingent, and complex."[27] 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 it had not been previously recognized.[28] While critical realism is a far less popular frame for policy analysis then neopositivism, it has been attractive to some because of its interest in mechanisms are a good fit with studies of processes.[29]

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[23] Ibid. p 108

[24] Ibid. p 111

[25] Ibid. p 109

[26] Ibid. pp 82-83

[27] Frank, "The Philosophy of Science and Intelligence: Rethinking Science in Support of Intelligence." p 38

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

[29] 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).

Analyticism

Analyticism moves away from neopositivism in a different direction than critical realism by rejecting the separation of mind and word. Instead, the approach argues that theory is an act of sensemaking that tries to explain what is being observed.[30] 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.[31] 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. Such models are rejected not for being wrong but for not being useful in explaining the specific case at issue.[32] 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.[33] While this approach is less dominant than positivism, the prominence of Max Weber[34] and John Dewey's work in the model has served to keep the tradition alive in policy studies.

Beyond offering this clarifying typology Jacksons work is focused on defending these traditions as being worthy of respect as equally viable, though differentiated, ways of conducting science. Work produced in one frame should abide by that frame's logic and should not be judged by the standards of the other frames.[35] This position has since been adopted by advocates of multi-method research who argue that the same methods may be used across frames but must follow the logic dictated by the frame to be valid. In other words, this tradition argues for pluralism but a pluralism that recognizes and respects distinction rather than attempting to absorb all tools.[36]

Three Philosophies of Science for Gaming

The question then becomes, can gaming be used to advance science in each of these three traditions, and if so, how? 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.[37] In examining the small theoretical literature on policy gaming, I find evidence of neopositivist, critical realist, and analyticist approaches to

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

[31] Ibid. p 142

[32] Ibid. p 143-144

[33] Ibid. p 147

[34] Ibid. p 114

[35] Ibid.

[36] 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). P 15

[37] Ibid. pp 11-13

gaming for policy research. Reflexivity is not common in empirical international relations,[38] and thus it makes sense that it is absent from discussion of policy gaming.[39] I also find evidence of exactly the type of cross-frame dismissal of other approaches that Jackson rails against. In the following section, I present the argument for three separate philosophical frames for gaming and argue that each should be treated as a separate, but valid, form of scientific gaming.

First, it is important to be clear that despite frequent claims to the contrary, policy games are designed to produce information about causality that can be transferred to potential events in the real world, including into the future. 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 decisonmakers in navigating the future,[40] they must in some way arm decisionmakers with correct information about cause and effect that can inform future decisions.[41] That is different than a guarantee of success, 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.[42] Many gamers opt to frame this limitation as games providing *indicative* rather than *predictive* information, an approach with which I generally agree.[43] However it is important to be clear that the work being done is fundamentally about establishing causal relationships. Too often, gamers (including in my own past work[44]) attempting to be modest about the certainty of our claims, introduce hesitancy about the nature of the claims we are making rather than our confidence in their strength. As a result, Jackson's focus on philosophies of science directed toward causal claim making is appropriate to apply to policy gaming.

Neopositivism

Perhaps unsurprisingly given the dominance of neopositivist thought in other areas of empirical social science and policy analysis, there is a robust community of gamers operating in

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[38] Ibid. p 11

[39] I believe the absence of reflexive policy gaming has more to do with the preferences of policy makers and consumers of research then it does with the potential of gaming as a tool for reflexive analysis. The focus on personal experience as a way of surfacing broader structures through post-structural or critical analysis has not proven popular with policy makers. That said, within broader discussions of gaming, the role of games in developing personalized understandings as a means of structural critique is recognized (for examples on these perspectives, see: Mary Flanagan, *Critical Play: Radical Game Design* (Cambridge, MA: MIT Press, 2009). and Elizabeth Sampat, *Empathy Engines: Design Games That Are Personal, Political, and Profound* (CreatSpace Independent Publishing Platform, 2017).), suggesting games do have a role to play in critical modes of analysis outside policy spaces.

[40] Work and Selva, "Revitalizing Wargaming Is Necessary to Be Prepared for Future Wars."

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

[42] Ibid. p 110

[43] 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).

[44] Elizabeth M. Bartels, "Games as Structured Comparisons: A Discussion of Methods,"ibid. (San Francisco, CA).

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.[45] Generally, these games focus relatively narrowly on demonstrating the connection between a difference in a single key factor with outcomes (for example, linking the presence of a drone vs. piloted aircraft with decisions that were more or less escalatory[46]) or the type of analysis provided to decisions makers with the arguments used in decision making (for example, the impact of broad vs. deep analysis on decisionmaking[47]). In other words, analysis from these games seeks to provide evidence of a simple causal relationship by tracing patterns of behavior in the game and makingclaims about other cases where we might expect this pattern to 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 scenario and role playing prevent appropriate generalization of game results onto real-world settings.[48] However, this problem is hardly unique to games, since many laboratory experiments also take place in somewhat artificial environments.[49] In fact, as one game designer eloquently frames the issue, games replicate more of the actual decision-making interactions than in other laboratory environments and thus produce findings that are more generalizable because they can better mimic interpersonal interactions and environmental complexity. The counter to this is that the researcher loses the level of control typically associated with experiments.[50] Because of inherent variation in people, and in interactions between them, full control across cases is impossible. Again, this concern is

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[45] For examples of this approach, see: Peter P. Perla, "Game-Based Experimentation for Research in Command and Control and Shared Situational Awareness," (Alexandria, VA: CNA, 2005); Andrew W. Reddie et al., "Next-Generation Wargames: Technology Enables New Research Designs, and More Data," *Science* 362, no. 6421 (2018); 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).

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

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

[48] Robert A. Levine, Thomas C. Schelling, and William M. Jones, *Crisis Games 27 Years Later : Plus C'est Deja Vu* (Santa Monica, CA: RAND, 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

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

[50] Interview with Jacqueline Schneider, Newport, RI, June 2018.

not unique to games—techniques like case study research have devoted considerable attention to accounting for alternative explanations.[51] Finally, the argument is made that the focus on crises and other extraordinary events inherently focuses games on "novelty and uniqueness";[52] 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 neopositivist work from occurring using other policy analysis tools. Taken together, the majority of arguments made against neo-positivist approaches to games are concerns about how such work is done, rather than the viability of the philosophical approach.

Critical Realism

An alternative approach to gaming focuses instead on games as tools for hypothesis generation through abduction—hallmarks of the critical realist approach to science. 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."[53] Part of the utility of games is 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 neopositivist approach, this approach argues that games work best when they consider broader complexes of causal factors and the processes by which they 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.[54] The underlaying 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 the 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.[55] 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.[56] He also argues against attempts at broad generalization, arguing for narrow generalization to similar cases and stresses that games

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[51] Bartels, "Games as Structured Comparisons: A Discussion of Methods."

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

[53] Compton, "Analytical Gaming." p 8

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

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

[56] Ibid. p 6

show what “can” or “may” happen if those specific scope conditions occur, rather than offering any type of law-like generalization.[57]

Analyticism

Finally, another group of texts focus on 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 “exmin[ing] why these events occurred—the combinations of player decisions and umpire determinations that produced them”[58] 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 type description that might be helpful in explaining real world decisions.[59] In other words, the outcome of analysis based on this type of game is the model of the problem that is built up, both by the initial game design, and by the contributions of players which flesh out how it evolves over time.

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.[60] In this model of inquiry, game designers and participants intentionally “distill” a problem by simplifying it enough that it becomes tractable and useful.[61] So long as the game attempts to “represent reality to the degree necessary to explore the warfare phenomena in which we are interested,”[62] these simplifications do not prevent us from advancing our 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[63]--it may be helpful in other contexts, but there should be no assumption that it will describe a generalized causal relationship.

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[57] Ibid. p 5

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

[59] 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

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

[61] Ibid. p 114

[62] Ibid. p 113

[63] Ibid. p 114

Three Separate but Equal Approaches

The arguments presented above offer three separate arguments about the way games generate useful information. Each follows a clear logic that is consistent with other scientific work, but they produce quite distinct types of claims, as summarized in Table 1.

Table 1: Implications of philosophies on games-based research[64]

Philosophy	Implications
Neopositivisim	• Preference for parsimonious theories in which a small number of factors drive differences • Research focused narrowly on the role of specific causal factors • Interest in application of the theory to a broader set of potential cases (generalizability)
Critical Realism	• Theories focus on causal mechanisms that may not be directly observable • Complex causal stories in which multiple causes interact to produce outcomes • Results applied to a small, carefully bounded population
Analyticism	• Focus on sense-making of a specific context • Research generates models that are useful in a specific context • Theory may be helpful to explaining other cases, but goal is to produce something useful for the specific case rather than a broad class of conditions

Existing texts tend to present themselves as offering singular, correct ways of producing knowledge from games, setting themselves in opposition to other approaches. Returning to Jackson's arguments in favor of a pluralistic approach to philosophy of science, we might draw a different conclusion—that there is more than one approach to scientific gaming, but that to produce valid information, gamers must work within a specific, explicit logic which stipulates how we draw information from a game.

Producing Scientific Knowledge with Game

Having established that games can produce information that contributes to scientific knowledge in multiple ways, I now turn to a consideration of what type of knowledge is produced and how it is generated. Three particular characteristics are key—the nature of the problems that are tractable to game, the decision about whether to treat the evidence from games as empirical or formal, and the decision about whether to look for evidence of causality through a difference-based approach or through causal mechanism. While these later distinctions need not align with the philosophical approach to inquiry selected, they often do.

[64] Table is modeled on a discussion of case studies in each philosophical frame offered in: Beach and Pedersen, *Causal Case Study Methods: Foundations and Guidelines for Comparing, Matching, and Tracing*. p 12

The Nature of Problems Suited to Gaming, and the Need for a Bayesian Approach to Certainty

One way to consider the type of information games generate is to compare games to other types of analysis. One of the most adopted frameworks for situating wargaming among other defense simulation tools comes from the work of John Hanley, who placed different techniques on a spectrum of indeterminacy associated with the problem.[65] Hanley highlights the difference between mathematical approaches that are determinist or feature only statistical or stochastic indeterminacy, and those that feature more structural indeterminacy. Mathematical approaches require that a state space be clearly defined, that persistent data be available, that units of measurement be understood, and relationships be determined in advance of analysis. Such problems have solutions that can be determined mathematically to produce either a point or distribution.[66] More complex, but still mathematically tractable problems feature strategic indeterminacy in which competitive dynamics between actors come to the fore (such as can be modeled in game theory).[67] In contrast, structural indeterminacy deals with problems for which we do not know "the bounds of the problem, what elements to include, and unknown relationships and data needed to perform mathematical calculations".[68] It is this latter class of problems to which games are best suited.[69]

The structural uncertainty inherent in the questions posed to games has deep implications for the level of certainty and confidence we can have in conclusions drawn by games. It has long been argued that games do not prove anything.[70] However, all three philosophies of science argue against treating the results of inquiry as settled fact. Neopositivists would argue that we can falsify, but not prove. Critical realists would argue that unobservable phenomena will always be an abducted theory as new observations change our understanding. Analyticism is interested in utility, rather than truth for its standard, and is thus unconcerned with proof. In other words, games may not prove, but neither do other forms of scientific discovery.

Instead, games can add to knowledge using any one of the three philosophical approaches described earlier in this chapter, but because our understanding of the problem features fundamental indeterminacies, we should be modest in our certainty about claims making. When a game generates support for the existence of a causal relationship, our uncertainty is not about

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[65] John T. Hanley, "On Wargaming" (University of Maryland, 1991). p 13

[66] "Some Theory and Practice of Serious "Futures" Games," in *Connections Wargaming Conference* (Carlisle, PA2019). pp 6-7

[67] Ibid. pp 6-7

[68] Ibid. p 9

[69] Parson, "What Can You Learn from a Game?." p 234

[70] For a famous formulation of this position see: Levine, Schelling, and Jones, *Crisis Games 27 Years Later : Plus C'est Deja Vu*. p 15

the nature of the relationship, but rather our confidence that what we see in the game is actually evidence of that causal relationship.[71]

One approach to articulating this type of uncertainty is to adopt a "folk Bayesian" approach to qualifying analysis.[72] Taking its cue from Bayesian statistics which focuses attention on how evidence for causality shifts confidence in our beliefs, this approach recommends that we carefully work to understand what pieces of evidence form the game mean for our causal argument. Such an approach requires careful consideration of what information could be generated by the game which would support or refute a particular causal claim before the evidence is collected. Once the evidence is gathered, we then need to assess whether the evidence collected actually supports or refutes our core claims.[73] In other words, we need to think first about what the evidence could tell us, then after setting those standards, use the standards to guide what we should take away from the game. Unlike in the original statistical approach, these results are unlikely to be a quantitative measure of certainty, but instead might resemble the types of confidence assessments common in the intelligence community.[74]

Game Evidence: Empirical or Formal?

One of the most discussed characteristics of a game is its artificiality—in the words of Bob Levine games feature both ersatz history (that is, fictitious scenarios) and people (in the form of role playing players).[75] When we use a game to inform us about the potential motivations of a leader in a fictitious crisis or course of action employed for a military capability that does not exist, the task of a game is fundamentally estimative or speculative,[76] making claims for which we do not yet (and may never have) observed historical events to serve as a check. As a result, for games to have policy utility, we must explain to an (often skeptical) audience what can be learned in the face of the artificial nature of games.

Two different understandings of what types of observations we are generating in game are in evidence. The first treats games as a data generating event, in which player decisions can be observed as events occurring in the world, and the resulting observations analyzed as empirical data. While findings must account for potential artificialities introduced by the synthetic environment and role-playing, this approach focuses on the fact that in the game real people are

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[71] Put more formally, our uncertainty is epistemological, not ontological in nature

[72] Adapted from Beach and Pedersen, *Causal Case Study Methods: Foundations and Guidelines for Comparing, Matching, and Tracing*. Chapter 6

[73] Ibid. p 156

[74] Richard J Heuer and Randolph H. Pherson, *Structured Analytic Techniques for Intelligence Analysis* (Washington, DC: Congressional Quarterly, 2011).

[75] Levine, Schelling, and Jones, *Crisis Games 27 Years Later : Plus C'est Deja Vu*. pp 3-12

[76] To use the terms employed by noted intelligence thinker Sherman Kent in: Sherman Kent, "Estimates and Influence," in *Sherman Kent and the Board of National Estimates: Collected Essays*, ed. Donald P Steury (Washington, DC: Central Intelligence Agency, 1994).

making decisions and experiencing consequences.[77] The game design is treated much as the experimental setup in a laboratory experiment might be—as infrastructure needed to generate the phenomenon and record data about it. The game design is the subject of study only to the extent that documentation is required for another researcher to reproduce the event or understand the data generating process in order to interpret the game's findings. Observations of game play are analyzed as empirical evidence of decisionmaking, just as historical records of decision might be treated.

An alternative perspective views games as models that incorporate humans as part of the simulation and which generate observations of the logical implications of the game's structure. In this view, game observations are not empirical—they are the logical extensions of the representations built collaboratively by designer and players that can be studied for insights in the same way as a technical drawing or computer simulation. In this frame, the game design is simply the designer's contribution to the model which is completed once the players introduce their understanding and see how the system of game and players evolves together over time. Game analysis attempts to describe what is happening in the model, which can then be related back to the real world. Inference can be drawn from the process about logical implications of the model, but such findings are based on formal, rather than empirical grounds.

While these distinctions do not map absolutely onto the divisions between the philosophical wagers differentiating the philosophies of science, as a general rule advocates of mind-world monism will be unlikely to view games as empirical. If independent observation is not possible, then it makes far more sense to treat both game designer and players as part of the theory generating unit, rather than treating the observers of the game as a separate entity capable of existing outside the system. In contrast, while neopositivist and critical realists may opt to treat game data as a model, these approaches prioritize data observed by an outside actor and thus will tend to encourage game analysis to treat game data as empirical observation.

Basis of Game Analysis: Differences or Mechanisms?

Scholars of research methods in the social sciences have long differentiated approaches to analysis that are based on measuring difference to demonstrate causation from those that focus on the process that connects cause and effect. While often advocates of one position argue for the superiority of their chosen approach, the reality is that they are different means of exploring

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[77] A more moderate version of this perspective argues that only a subset of types of observations from a game can be treated as empirical data. For example, a body of work by scholars at the Naval War College argued that command and control decisions were a unique are of games in which actually communication and decisions, rather than simulated ones, occurred in game and thus were appropriate to treat as empirical evidence. For more details on this argument, please see: Perla, "Game-Based Experimentation for Research in Command and Control and Shared Situational Awareness."

causality, which will persuade different people.[78] Both can be applied to games, and while again there is not necessarily a one-to-one relationship between the selection of an approach and the philosophical frame of the work, there are strong tendencies that tend to link them.

Difference-based approaches make the fundamental argument that we can understand causality by comparing what happens when a cause is present and absent, and comparing the difference in outcome. In practice this can be done either by comparing across cases, or by comparing a case to a logical argument about what would have transpired.[79] In the social sciences, because there are usually multiple sources of variation, pains must be taken to attempt to control other sources of variation to make difference-based claims compelling, and when such control is not available to explain logically why potential confounding explanations are less credible than the primary causal argument.[80] The disadvantage of this approach is that while it may demonstrate clear evidence of cause and effect, it cannot provide much information about how the cause actually produces an outcome,[81] which is often of great interest to policy-makers attempting to construct new interventions or anticipate second order effects of strategies. Critics are especially likely to attack counterfactors that are based on logic rather than observation, since often compelling arguments can be put forward for alternative scenarios that also appear plausible.[82]

In contrast, a focus on causal mechanisms seeks to lay out how causation actually occurs by laying out the process that connects cause to effect. This must be more than a narrative story about what events occurred in what order, instead we must map out a system that can explain why "causal force" is transferred through the causal mechanism to produce the observed result.[83] In other words this approach focuses on the activities that link different parts of the system, rather than focusing on factors that may be present or absent—the system as a result is more than the sum of its parts and is liable to be misunderstood if it is atomized.[84]

Based on these descriptions, it is perhaps not surprising that as a general rule, neopositivist and analyticists tend to gravitate towards difference-based explanations, and critical realists towards mechanistic explanations. However, there are some key nuances that complicate this division. While both neopositivist and analyticist approaches lean on counterfactuals to explore differences that can flesh out causal relationships, in practice counterfactuals used differently by each approach to science. In neopositivist research, counterfactuals are used to explore how a

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[78] Beach and Pedersen, *Causal Case Study Methods: Foundations and Guidelines for Comparing, Matching, and Tracing*. pp 27-28

[79] Ibid. p 28

[80] Ibid. p 30

[81] Ibid. p 31

[82] Ibid. p 40

[83] Ibid. p 35

[84] Ibid. pp 37-38

causal relationship works across different cases. In contrast, analyticist approaches use counterfactual to explore alternatives to what did happen in a single case—for example, by highlighting the differences between a model and a case as a means of helping us understand what did happen in the specific case.[85] This alternative form of counterfactuals is not at all interested in numerically measuring difference across cases, but rather in an act of imagining how the narrative of events would be altered by different conditions based on the researchers' prior experience. Put differently, in analyticism, causal factors are those we cannot imagine not being present and still having the outcome in question occur.[86] While this approach depends on counterfactuals, and thus uses a difference-based approach to demonstrating causality, the analyticist frame's commitment to narrative complexity can move it towards a more mechanistic mode of argumentation. At the same time, some neopositivists argue that mechanisms may be explored practically by breaking up the process into a series of smaller causal relationships, which can then be investigated using a difference-based method.[87] Put simply, it's possible to construct arguments that draw on both difference-based and mechanistic style arguments, and so it is worth being explicit to ensure that the logic of argumentation is clear, and claims can be properly evaluated.

Different Philosophies for Different Types of Games

In addition to considering how the three alternative philosophies shape gaming in general terms, we may also consider how games with different purposed relate. The four archetypes, or ideal types, that describe the purposes of policy games are: system exploration, alternative conditions, innovation, and evaluation.[88]

System Exploration: This archetype highlights games that bring together diverse stakeholders to contribute their understanding of the policy system to generate a thick description. The primary goal of such games is to elicit and synthesize designers' and players' mental model of a policy problem and how it may evolve over time. The output from successful system exploration games is a representation or model of the problem that combines insight from players with research performed by the design team to improve the sponsor's understanding of the nature of the problem.

Alternative Conditions: These games aim to detect patterns of decisionmaking based on similarities and differences in the decisionmaking environment to help advance causal inference.

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[85] Jackson, "The Conduct of Inquiry in International Relations: Philosophy of Science and Its Implications for the Study of World Politics." p 115

[86] Ibid. pp 148-149

[87] Beach and Pedersen, *Causal Case Study Methods: Foundations and Guidelines for Comparing, Matching, and Tracing*. p 36

[88] A longer description of these archetypes can be found in: Elizabeth Bartels, "Archetypes of Information Produced by Analytical Games" (paper presented at the International Studies Association, Toranto, Canada, 2019).

Game designs of this type try to minimize variation in environment, actors, rules, and model across iterations while purposefully changing selected key factors. Successful games of this type produce an understanding of the influence of varying conditions on either the decisionmaking process or the eventual decisions.

Innovation: Innovation games seek to develop new decision options that break from the status quo as a form of policy ideation. These games build a model of the world that relaxes constraints in the hopes that doing so might enable new approaches to problem solving. In this way, they share similarities with hypothesis generation and brainstorming activities. The ideal outcome is for this type of game is to generate one or more promising ideas for further consideration.

Evaluation: The evaluation archetype describes games that aim to judge the potential outcomes of player decisions based on a normative standard—in other words, to evaluate policies, courses of action, or interventions. These games focus great attention on adjudication to generate credible outcomes from player decisions. Because the game must project plausible outcomes in order to enable evaluation of the results of decisions, it must contain a fairly well-developed theory of causality that allows the game staff to project different counterfactual outcomes based on player actions. The desired outcome of these games is an assessment of the potential gains and losses from following a course of action.

As I argue below, some archetypes fit more harmoniously with some philosophies, while others give rise to tensions. Without going so far as to say any archetype is incompatible with any philosophy, there are clearly types that fit more naturally with certain logical approaches to knowledge production. Since designers tend to naturally gravitate to one philosophical position, these suggest that some types of games may be more natural for a designer to produce.

System Exploration

To a neopositivist, system exploration games have profound limitations. The openness needed to allow players to contribute their mental models of the problem makes it difficult to clearly isolate key factors or causal relationships during the game. Much like the neopositivist view of a single case study, games might be useful as a source for inductively generating hypotheses[89] but are unlikely to advance causal claims.[90] However, they have the added defect of artificiality, making them strictly inferior to a real-world case for this purpose.[91] Thus, one strongly inclined toward neopositivism is likely to only use systems exploration games as a means of hypothesis generation about phenomena for which no real-world case study can be generated.

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[89] Levine, Schelling, and Jones, *Crisis Games 27 Years Later : Plus C'est Deja Vu*. pp 12-14

[90] Gary King, Robert O. Keohane, and Sidney Verba, *Designing Social Inquiry: Scientific Inference in Qualitative Research* (Princeton, NJ: Priceton University Press, 1994). pp 210-212

[91] Parson, "What Can You Learn from a Game?." pp 237-238.

In contrast, system exploration games align quite well with the logic of analyticist research. If science is primarily an act of sense-making, then the use of games to develop a simplified model that represents the designer's and players' efforts to understand the phenomena of interest appears to be quite a useful activity. If the designers and players (or those who encounter the resulting model) find the resulting simplified model useful, either when confronting a similar problem in the real world or in setting further analytical research programs, then the exercise of system exploration gaming is useful to this mode of inquiry. Given the ample evidence we have for players and researchers finding utility in gaming,[92] practitioners of analyticism will have no problem making a case for the pragmatic usefulness of games to explore issues.

Critical realists are likely to find more value in systems exploration games than their neopositivist counterparts, though perhaps not be as strong advocates as their analyticist counterparts. Because games allow for the observation of specific processes, they are ideal for tracing out causal pathways. This makes them an attractive option for mechanism-based research for which rich contextual data enabling abduction is critical. However, the inherently unobservable nature of critical realist mechanisms may make the artificial nature of games more of a concern. It is one thing to abductively infer an unobservable phenomenon from real world observations, but to do so from the interactions of an inherently fictitious environment and actors may reduce confidence in the value of the causal claim. Thus, games are likely to be seen by critical realists as an imperfect means for generating causal claims, with appropriateness dependent on the specific topic.

Alternative Conditions

The alternative conditions approach fits extremely well with the neopositivist research agenda. Use of structured cross-game comparison in alternative conditions games make them ideal for studying causality through a difference-based lens. While the inherent variation between players and their interactions prevents perfect experimental control,[93] this can be managed in ways that are consistent with quasi-experimental traditions that are popular in a wide range of neopositivist research projects.[94] Because the researcher is able to observe the decision process, there is ample opportunity to measure a range of potential causes and their influence on decisionmaking. In other words, alternative conditions games are explicitly framed using the logic of neopositivist research and thus fit neatly into the philosophical frame.

In contrast, for both critical realists and analyticists, this approach sits uneasily within their logics of inquiry. Both traditions are interested in complex contexts with many interacting factors that need to be considered holistically. Attempts to isolate and then vary specific factors in

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[92] For example of a famous assertion of the utility of gaming, see: Levine, Schelling, and Jones, *Crisis Games 27 Years Later : Plus C'est Deja Vu*. p 23

[93] Parson, "What Can You Learn from a Game?." p 238.

[94] Elizabeth M Bartels to Paxsims, 2015.

isolation breaks this commitment. For critical realists interested in causal mechanisms not counterfactuals, the comparative project here provides relatively little additional leverage to help understand the causal process. Multiple cases may help illustrate how a mechanism works across a small subset of cases, but intentional variation is really only helpful in defining scope conditions for the universe that can be generalized to. This most likely can be done better using other logical tools. For analyticists who are not invested in generalization as a goal of science, cross-case comparison offers no advantage for inference. While it may be interesting to see if the same model is generated across multiple game settings, that is more appropriately the role of multiple games analyzed together rather than any type comparison across games with structured variation. In short, this archetype generates comparative information that is less valued by these two philosophical approaches.

Innovation

Much like system exploration games, the hypothesis-generation focus of innovation games makes them a somewhat uneasy fit with neopositivist approaches. Because of the artificial nature of games, inductively generated hypotheses may gain less traction with adherents of the approach. Furthermore, novel approaches are unlikely to be reducible to discrete factors; if the solution was that simple it likely would have been suggested in the past. In these cases, the task would be more a matter of eliciting existing but neglected good ideas from participants, and thus more properly be thought of as a system exploration game than a true innovation game. As a result, innovations games are not likely to be popular with neopositivist practitioners.

Perhaps the most natural alignment for innovation games is with the critical realist approach. Critical realist models of innovation games focus on generating a strategy through abduction—that is, players use the context of the game, including competitive pressures, to generate a strategy. The focus on causal mechanisms pairs nicely with the need for attention to policy process. That is, players cannot simply identify a causal factor to define a strategy, but rather must play out how to enact change over time, through actions and mechanisms that can produce the effect of interest. Critical realists would argue that the resulting theory of success has not been proven to be true, but merely generated as a potential theory for testing as additional evidence is gathered is also highly consistent with the generation of innovative ideas.

Analyticist approaches to innovation games share some characteristics with system exploration games, but do not align as well. On one hand, the pragmatic orientation of analyticism is well suited to the task of developing new approaches that are simple enough to be easily communicated outside the game. On the other hand, because that model cannot be assumed to apply elsewhere, the value of the game for policymakers is conscribed. As a result, the specific problem at hand will likely deeply influence analyticists assessment of the utility of a innovation game.

Evaluation

Evaluation games have an imperfect fit with neopositivist approaches. Evaluation games share a common causal setup with most neopositivist evaluation. The catch is that rather than observing direct effects of the causal relationship as in alternative conditions games, game outcomes depend to a substantial degree on the use of a model to generate outcomes. Because adjudication models must, by definition, bake in a model of causality, the game cannot be used as evidence of the truthfulness of that causal model since it is endogenously connected to the results. Concretely, if a weapon's system is attributed with great destructive power in the adjudication model, findings of the weapon's destructive power are not an empirical result, they are a model artifact that contributes to neopositivist research only to the extent that the model has been generated using other approaches. As a result, while carefully done research is possible, neopositivists are likely to be skeptical of games for evaluation until evidence of either credible adjudication or lack of dependence on endogenous models is demonstrated.

Critical realist approaches to evaluation games are also possible but process some sharp limitations. Critical realism's focus on causal mechanisms puts greater weight on the evaluation of process than do neopositivist approaches that focus on measuring effect size through differencing. However, critical realists would be quite hesitant to make strong claims on the back of games alone—games can present evidence that is consistent with the posited causal process, but strong evidence likely requires other research approaches to generate. Furthermore, results may only be generalized to a very narrow set of cases that share similar context. Because games involve many artificial elements, it may be more difficult to define what set of cases the theory might reasonably extend to.

Analyticism also coheres with the goals of process evaluation to some degree, but the claims that result from such analysis are somewhat different than for the other two approaches. In analyticist approaches, the ideal type model is judge by usefulness—so an analyticist evaluation game might be best thought of as a test for the usefulness of some model of policy in a particular situation. The catch is that the situation is fictitious, and analyticism does not support efforts to generalize. Thus, the output of an analyticist evaluation game is the determination that a model is useful for the specific context of the game. It may prove to also be useful in other contexts, but may not, and the researcher must accept, and defend, the risk that game results will not prove to have real world utility before undertaking such an effort.

Conclusions: Different Games for Different Philosophies, Different Claims from Different Games

Taken together, the arguments above suggest that some archetypes of games are better aligned with some of the philosophies of science that can apply to games, as summarized in Table 2. That is not to say that poor alignment prevents a clever researcher from developing a game-based approach using that philosophy, but it does suggest they will have to do more work

to defend why the approach is logically consistent to other researchers who adhere to that philosophy. Given the dominance of neopositivism in other approaches to policy analysis, consideration of potential objections from that logic may be particularly important for a designer working outside that philosophical tradition, or for a neopositivist designer using a game archetype that is a less comfortable fit for the neopositivist logic of inference.

Table 2: Degree of alignment between the three philosophies and four archetypes

Archetype	Neopositivism	Critical Realism	Analyticism
System Exploration	Weak	Some	Strong
Alternative Conditions	Strong	Weak	Weak
Innovation	Weak	Strong	Some
Evaluation	Some	Some	Some

Another implication of the differences in how each game type supports the logic of the different philosophies is that designers who adhere to a specific philosophy may find one style of game more natural to design then a type that fits less well into their philosophy. For example, a strong neopositivist may be inclined to see system exploration as a less useful enterprise than an analyticist scholar would. In contrast an analyticist is likely to see alternative conditions games as needlessly fussy, while a neopositivist would see their structure as critical to support cross-case comparison. These tendencies are not absolute—many designers are capable of adopting different logics or of identifying value for a game type within their logic. However, the tendency is useful to note, if only to be sensitive to the potential to dismiss too readily the utility of games that exist outside our preferred philosophical frame.

Similarly, a designer working outside their preferred philosophical frame must be careful that the types of claims they are making are consistent with the philosophical claims they are working under in a given project. For example, a neopositivist may be more inclined to view game data as empirical, but when working in a analytist mode to produce as system exploration game that may lead the designer to slip into the language of generalization, even when that is not an appropriate move within the analytist philosophy. Again, the point is not to wed the designer to a single philosophy, but rather to sensitize the researcher to their own mental habits so that they can be consciously considered.

This last point brings us back to the starting point of this paper: that game design requires a systematic approach that can be found in science. However, as this paper has demonstrated, there is more than one way to do science, and different commitments to science will tend to lead to different types of games that provide different evidence to support claims-making. In building a scientific approach to gaming, our efforts should recognize that diversity and accept different approaches so long as they can be tied back to a clear set of philosophical claims.

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