SAND2019-6332C

PROJECT ON NUCLEAR GAMING

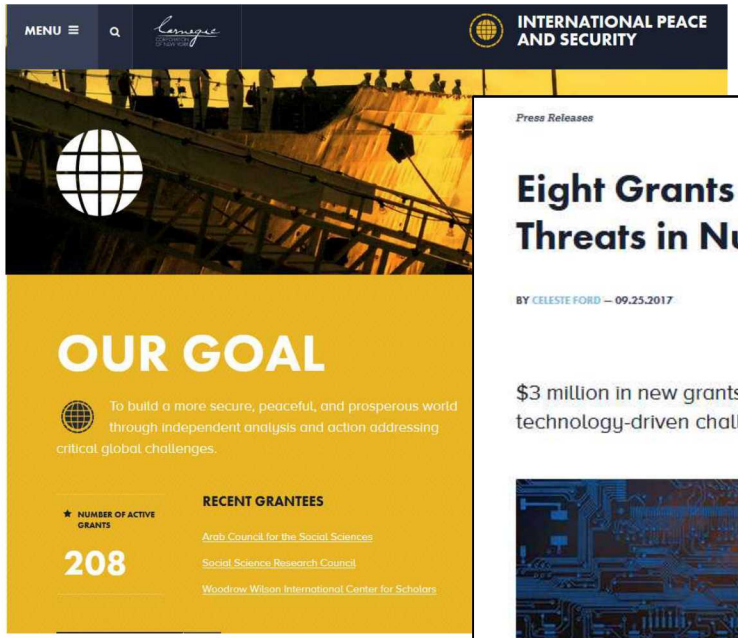
Experimental Gaming: Introducing the Project on Nuclear Gaming's SIGNAL Framework

PRESENTED BY

Andrew Reddie, *University of California, Berkeley*

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

The Project on Nuclear Gaming is supported by the CCNY International Peace and Security Program.



Carnegie Corporation of New York

$500K funding over two years

"…assess the implications for global strategic stability of advances in technologies…"

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The Project on Nuclear Gaming is a consortium.

- UC Berkeley Goldman School of Public Policy
- Nuclear Science and Security Consortium, an NNSA-sponsored program to develop new generation of laboratory-integrated nuclear experts

- Systems Analysis and Engineering experience
- Support application of Sandia experimental and serious game technology & subject matter expertise
- Mentoring and hosting of student interns

- Center for Global Security Research
- Providing expertise in weapons effects and international security
- Mentoring and hosting of student interns
- Organizing and hosting project workshops

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The Project on Nuclear Gaming

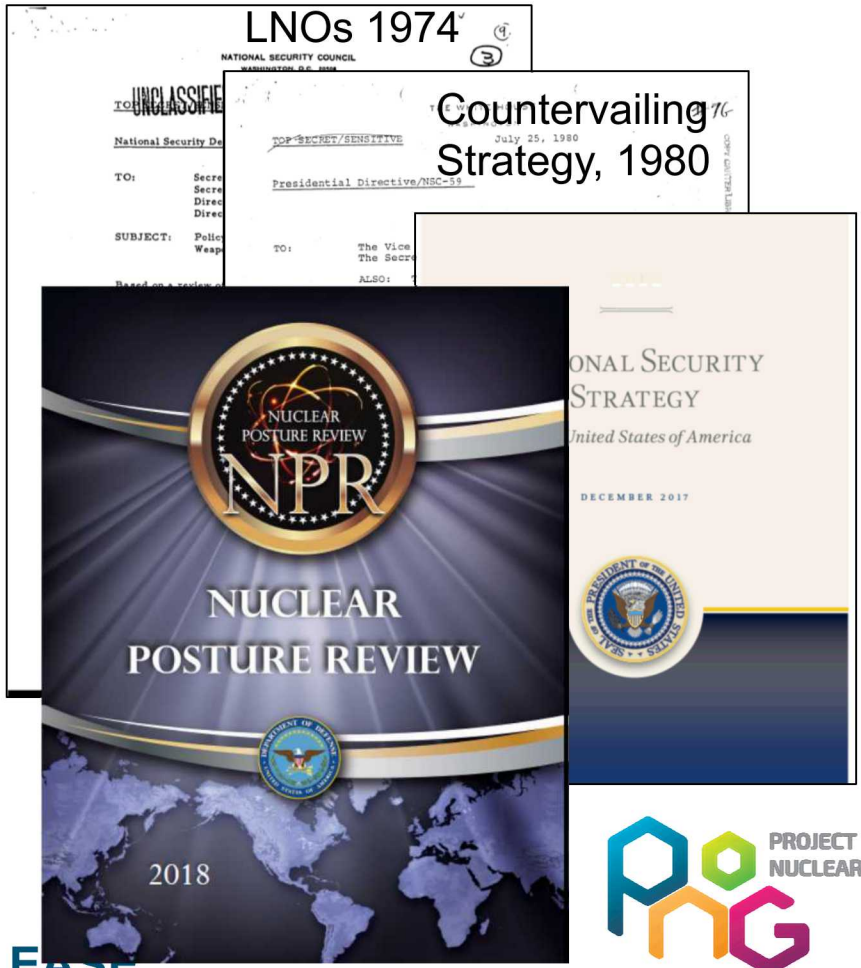
Research Questions:

- How can experimental games be used to examine real-world problems?
- What impact might varying weapon capabilities have on deterrence and strategic stability?

Partnering and Mentoring Objectives:

- Strengthen and leverage existing partnerships between National Labs and Universities
- Engage the next generation of scientists, analysts, and researchers on nuclear matters

PoNG is NOT making an assessment of any specific national policy or conflict scenario, but is informed by a long history of strategy and concepts.



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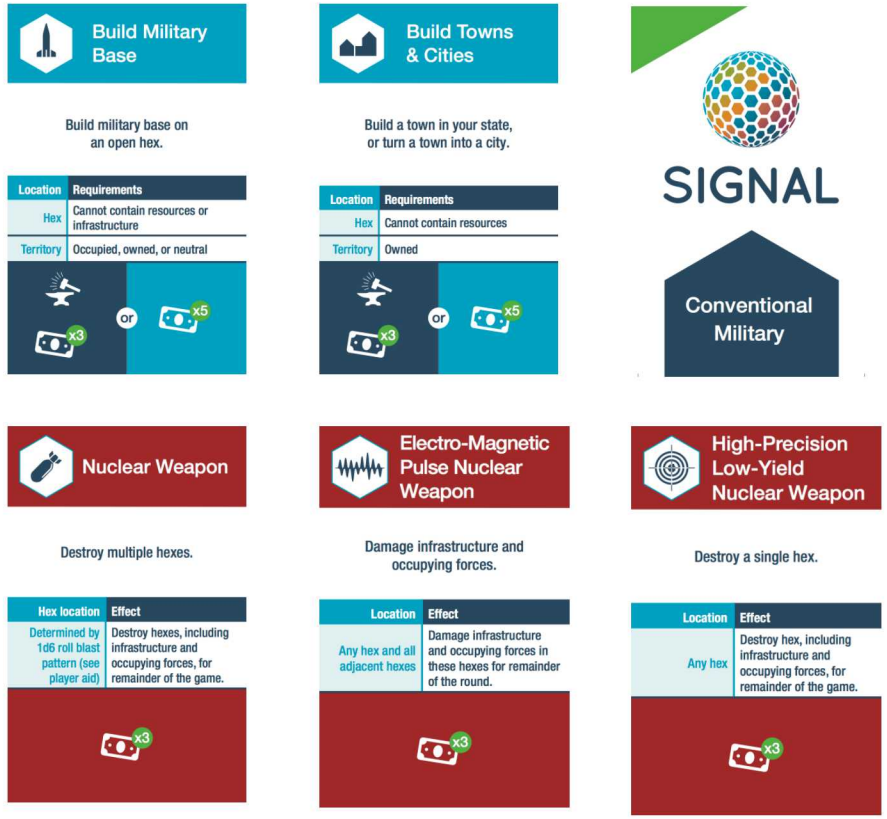
What happens when “tailored effects” nuclear weapons are introduced into a conflict scenario?

AR6

- Do these weapons change the dynamics of conflict escalation?
- Do they alter the nuclear threshold (morally, tactically, or otherwise)?



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Slide 5

AR5 Do want to use this explicit RQ...
Andrew Reddie, 5/28/2019

AR6 Complexity-scarcity gap digram?
Andrew Reddie, 5/28/2019

Research Design: How Should We Study Nuclear Deterrence?

AR7

Traditional Approaches:

- Empirical data
- Formal models
- Computer-based models
- Survey Experiments

Our Contribution:

- Experimental Gaming

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Slide 6

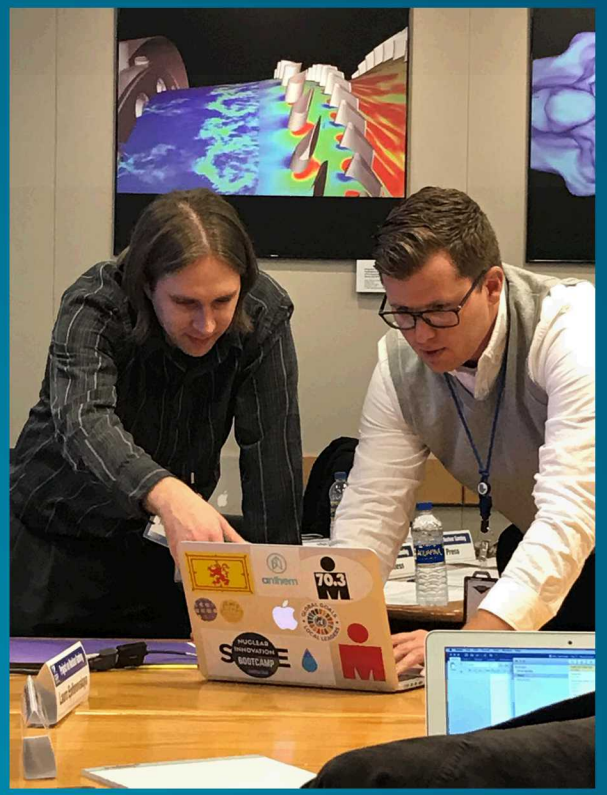
AR7 We need to tell a story about why alternative DGPs are inappropriate and concerning how we arrived at the method that we're using today.
Andrew Reddie, 5/29/2019

Wargaming has a long history…

Seminar and Scenario-based Wargaming

- Designing around identified policy challenges
  - Useful for policy-oriented inquiry
- "Open-ended" design with large game staffs and in-depth preparation
  - Blue, Red, and White Cell games
- Engaging high-level policy-makers
  - Training, education, and strategy

- Ex. Deterrence and Escalation Game and Review (DEGRE)



PoNG's SIGNAL TTX at LLNL, May 2018

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… And some limitations

Existing wargaming methods do not provide for outcome-oriented inference:

- Generalizable insights require data to perform large-*n* analysis.
- Experiments have standards with regard to *replication* and *reproducability*
  - Often, existing games vary on the basis of how they are presented, the identity of the players, and actions taken within the adjudication cell.
  - Few games split their player populations into *treatment* and *control* groups to test a variable of interest.
  - Sponsor bias

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Experimental gaming aims to be…

Replicable and Reproducible

- Strengthen our conclusions and address human variability by replicating a set of initial conditions and capturing significant quantities of data.

Controllability

- Allow for variable manipulation in initial conditions as well as in-game manipulation.

Clear Instrumentation

- Capture clear data about when a player chooses to perform actions in the game.

Neutrality

- Researchers uninvolved with the actual data gathering, reducing bias.

Fidelity/Complexity

- Creating a simulation that captures the key features of the world surrounding the research question.

SIGNAL represents our team's first experimental gaming platform…

Incorporates "elements" of deterrence
- Military
- Economic
- Political/diplomatic

Incorporates "dynamics" of deterrence
- Bargaining
- Signaling
- Uncertainty

SIGNAL

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The Project on Nuclear Gaming uses controlled experiments…

SIGNAL Online (Any Players)

- Highly structured scenarios
- Rules-based adjudication
- Structured player dynamics
- Quantitative data collection

SIGNAL Board (Knowledgeable and Expert Players)

- Highly structured scenarios
- Rules-based adjudication
- Fluid conversation and over-the-table player dynamics
- Improved quantitative data collection

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… and benchmarks

SIGNAL TTX (Elite Players)

- Fluid exploration of scenario features, player concerns, and boundaries for outcomes
- Control team adjudication
- Qualitative and narrative data collection

SIGNAL Survey Experiment

- Questionnaires focused on evaluating subject responses to specific situations
- No dynamic interaction
- Serves as a control set

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High-level statistics from different treatments have similarities and differences.

Metric	All Rounds		Without Last Round	
	Traditional	Tailored	Traditional	Tailored
Number of Games	19	27	19	27
Total Actions	757	1103	504	839
Average Actions Per Game	39.8	40.9	26.5	31.1
Conflict Actions	276 (36%)	385 (35%)	163 (32%)	290 (35%)
Conventional Actions	175 (23%)	203 (18%)	106 (21%)	157 (19%)
Nuclear Actions	44 (6%)	124 (11%)	21 (4%)	90 (11%)
Traditional Nuclear Actions	44 (6%)	105 (10%)	21 (4%)	77 (9%)

NOTE: While based on real data, these results are preliminary, non-conclusive, and for illustration only.

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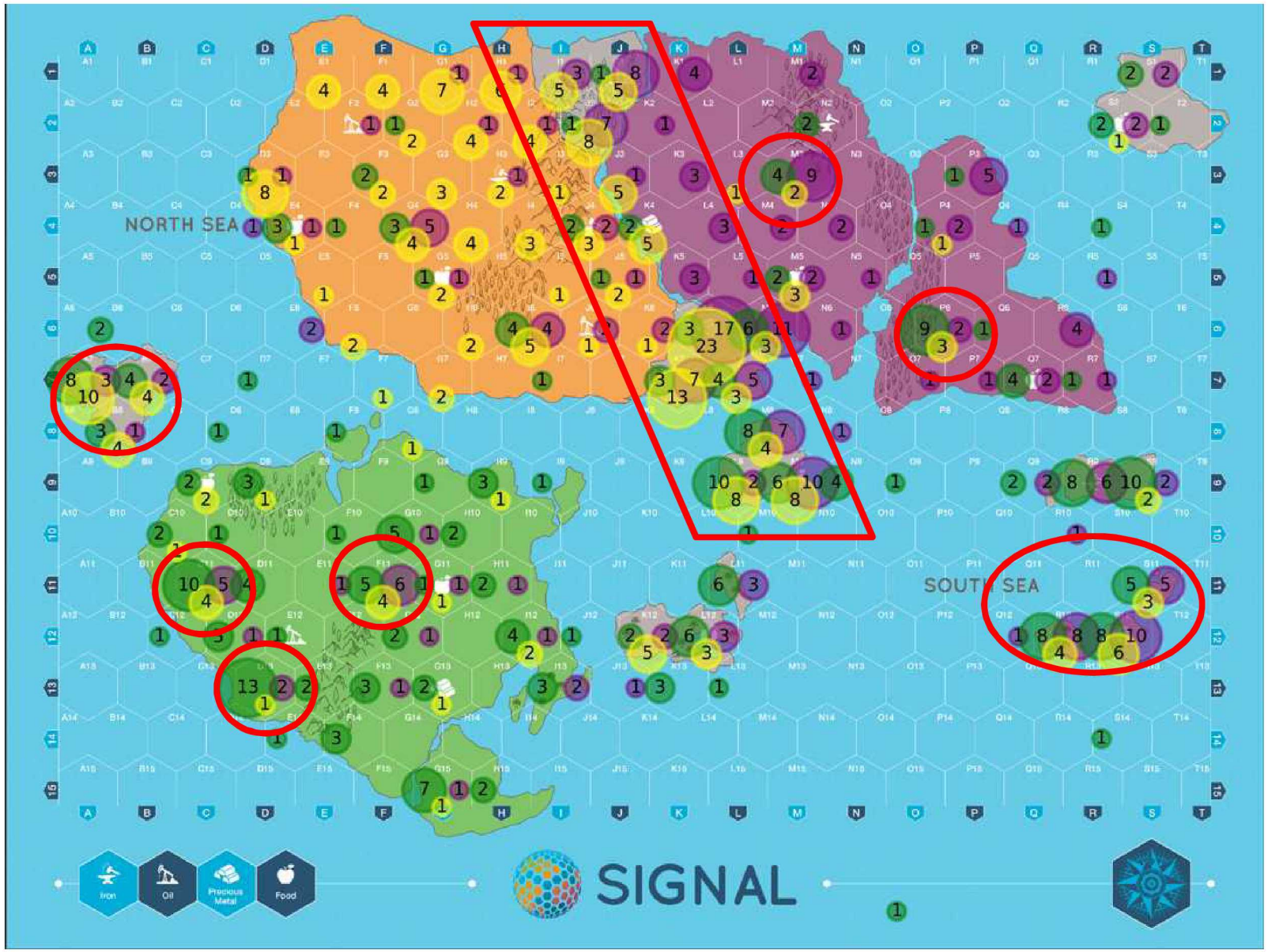
This method allows us to…
Illustrate trends in player behaviors and strategies



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To analyze the likelihood of nuclear use…

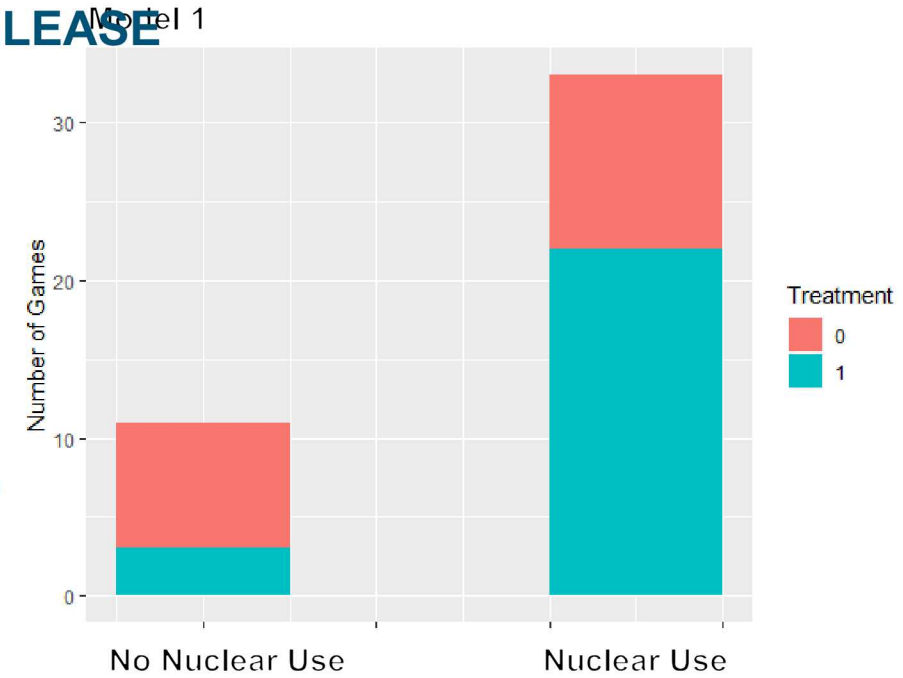
Using probit regression models, the treatment condition in which player are given additional HPLY and EMP capabilities yields a **higher** predicted probability of nuclear use.

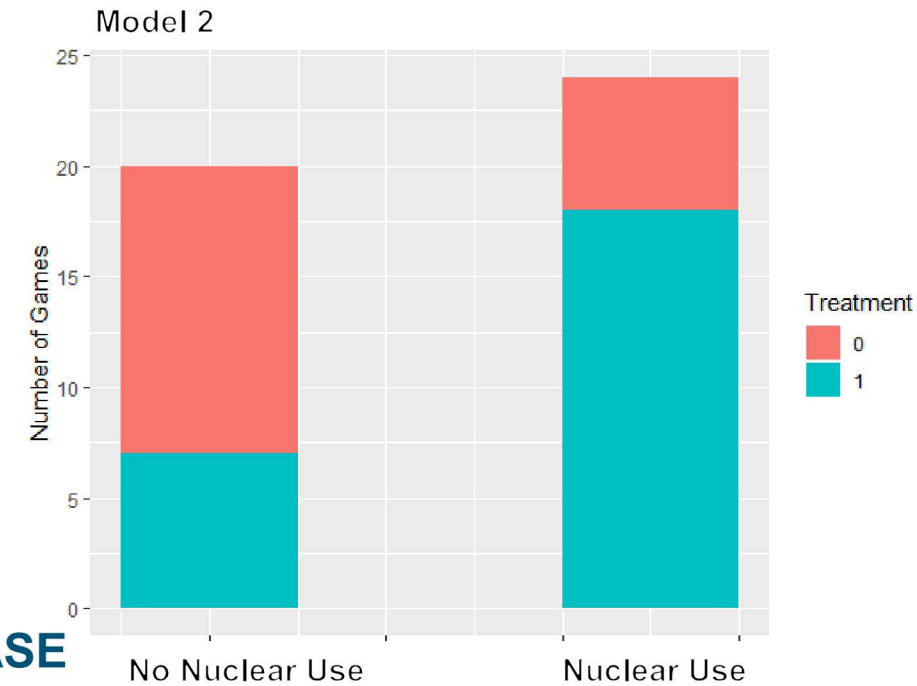
Table 1: The effect of the treatment variable (incl. EMP and HPLY capabilities in player arsenal) on nuclear first use.

	(1)	(2)
	Model 1	*Model 2*
Treatment	0.96 (.44)**	1.06 (.40)***
N	44	44
Log-likelihood	-22.11	-26.67
Constant	0.20 (.29)	-0.48 (.30)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

*Model 1 includes all rounds of each game in analysis.
*Model 2 omits the final round of each game in analysis.





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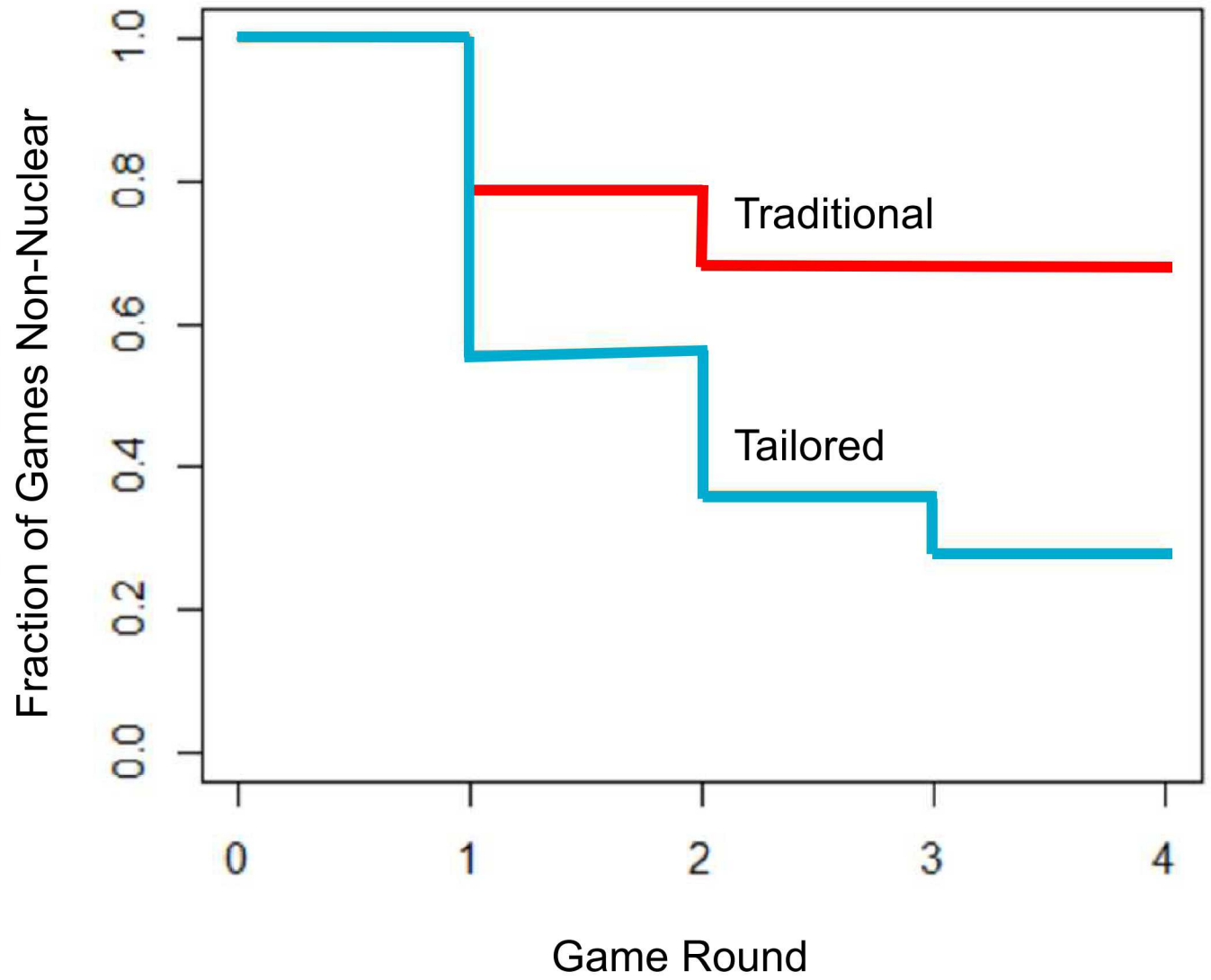
Slide 15

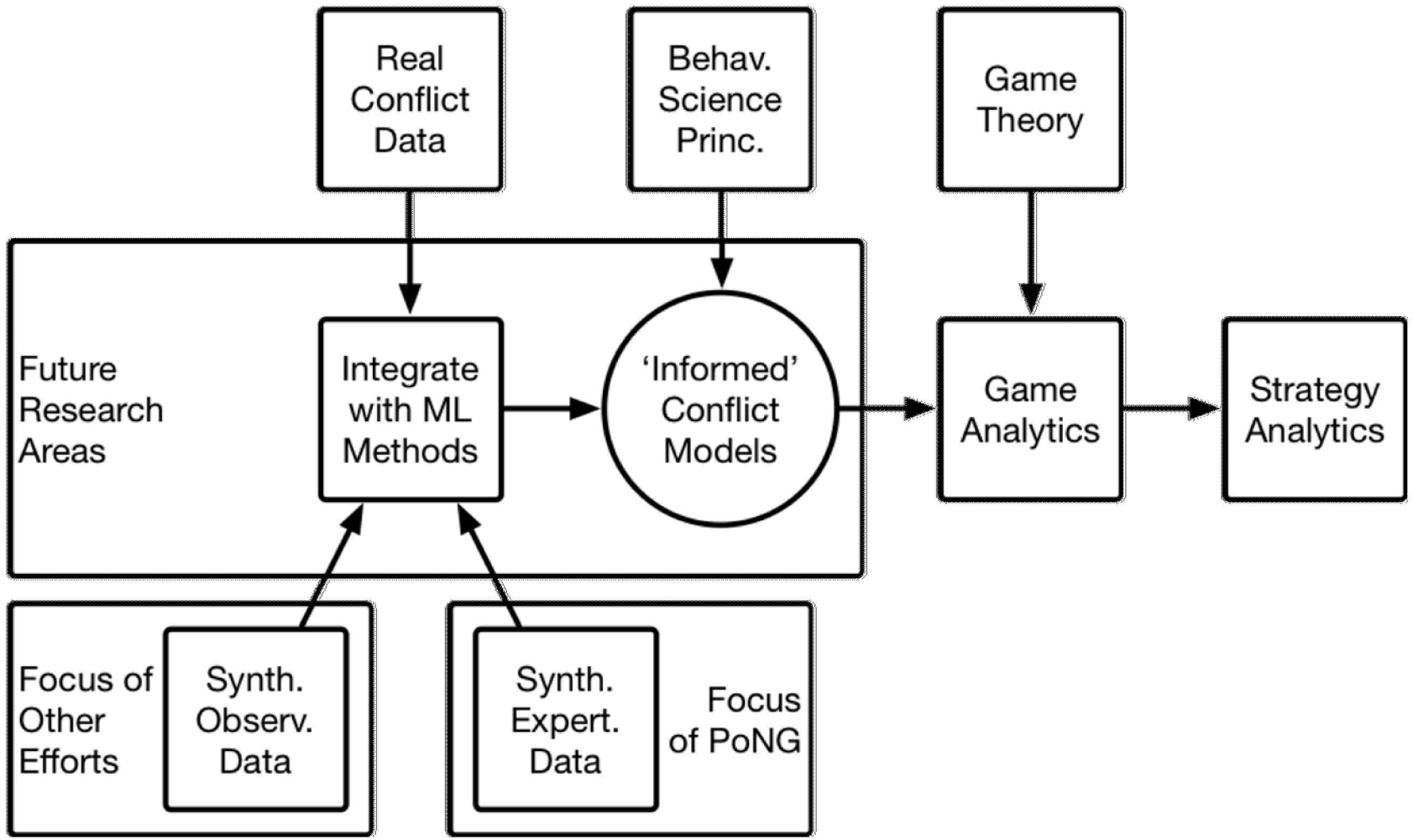
AR4 Adding the requested graphs makes for a busy slide so please do re-arrange as you'd like. The graphs strike me as descriptive statistics rather than a finding from analysis, too, if you'd like to move them up.

Andrew Reddie, 4/28/2019

And to explore differences in escalation dynamics over time…



The Project on Nuclear Gaming is also part of a bigger vision for enhancing the study of conflict.



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The Project on Nuclear Gaming:

- Michael Nacht (PI), Bethany Goldblum, Andrew Reddie, Manseok Lee, Camila Valenzuela, Soravis Prakkamakul, Roshan Kirshnan, Jake Tibbetts, Chris Zheng, Vamshi Balanaga, Roshni Iyer, Sarah Laderman, Janani Mohan

- Sheryl Hingorani (PI), Jason Reinhardt, Kiran Lakkaraju, Jonathan Whetzel, Laura Epifanovskaya, Joshua Letchford, Alexandra Valdez, Vamshi Balanaga

- Wes Spain (PI), Craig Wuest, Andrew Reddie, Jake Tibbetts

Q+A

pong.berkeley.edu/signal/

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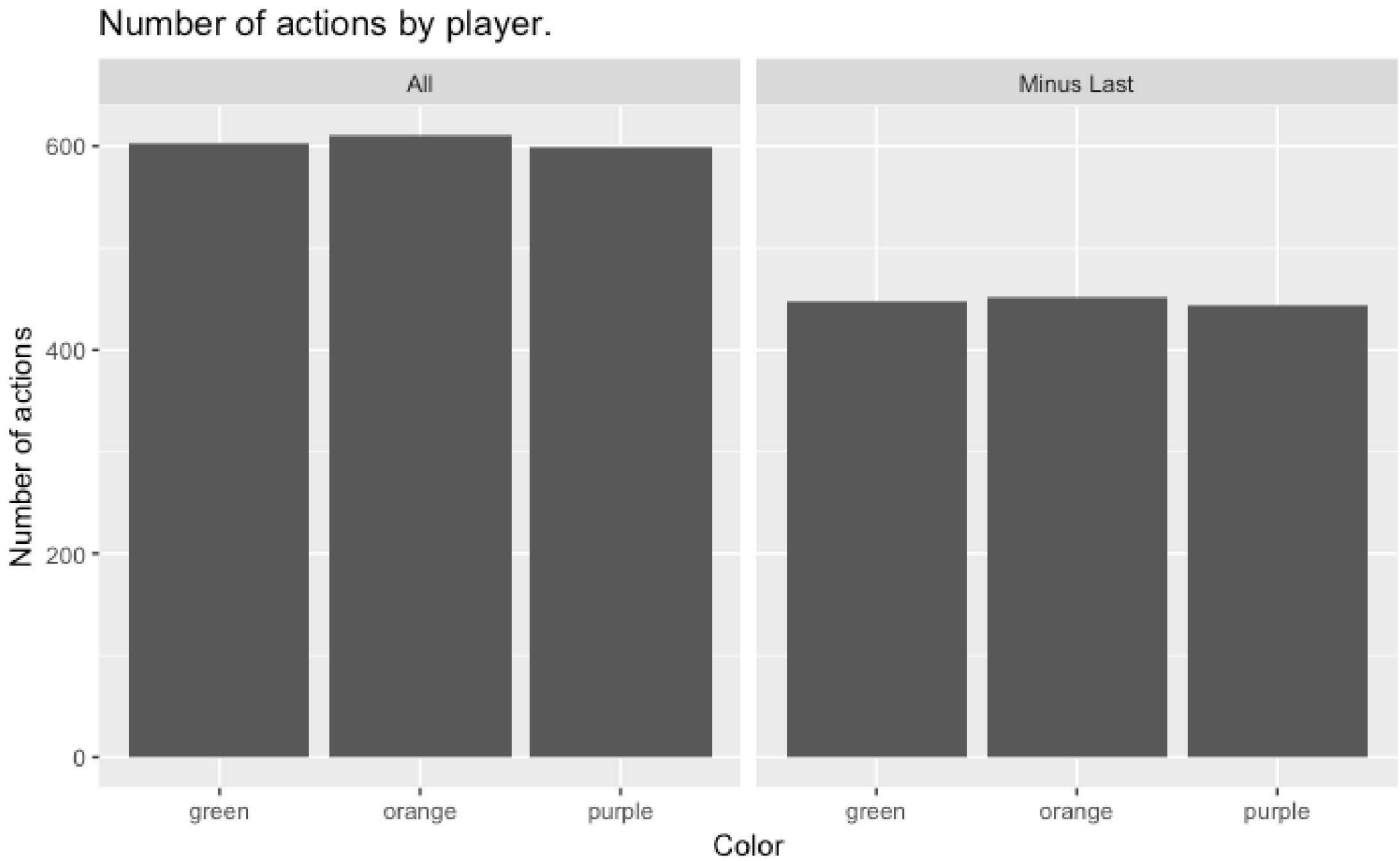
Back-Up Slides

SIGNAL is designed for the research question and to minimize bias – the game IS the lab.

- Non-nuclear and Nuclear players both won games.
  - Non-nuclear player won game ~38% more times than nuclear.
  - Each Nuclear player wins at approximately the same rate
- Players are not giving up, and engaging throughout the game
  - All players executed roughly similar numbers of actions



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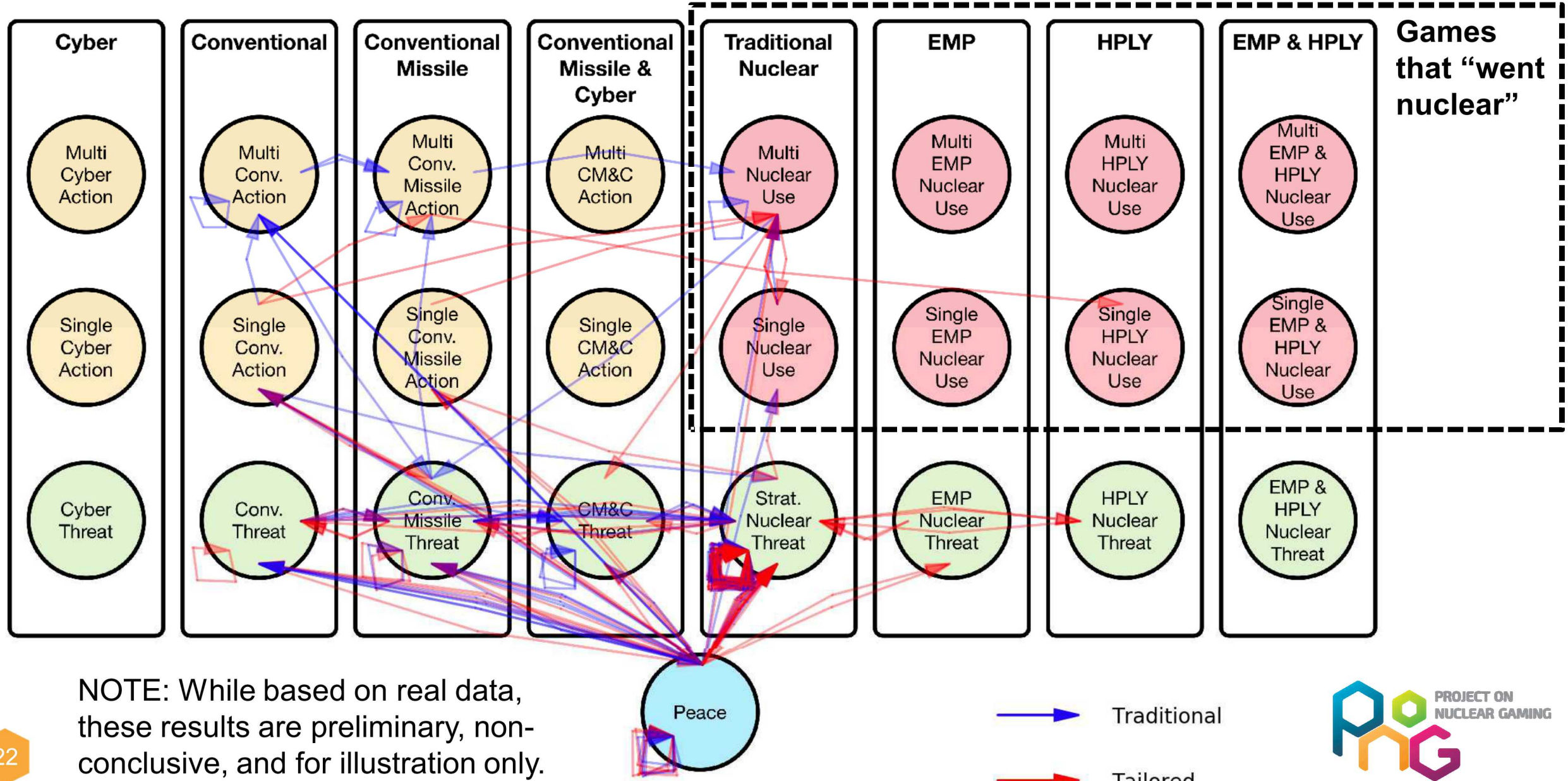
Establishing Conflict Classes from raw data enables analysis of escalation dynamics.



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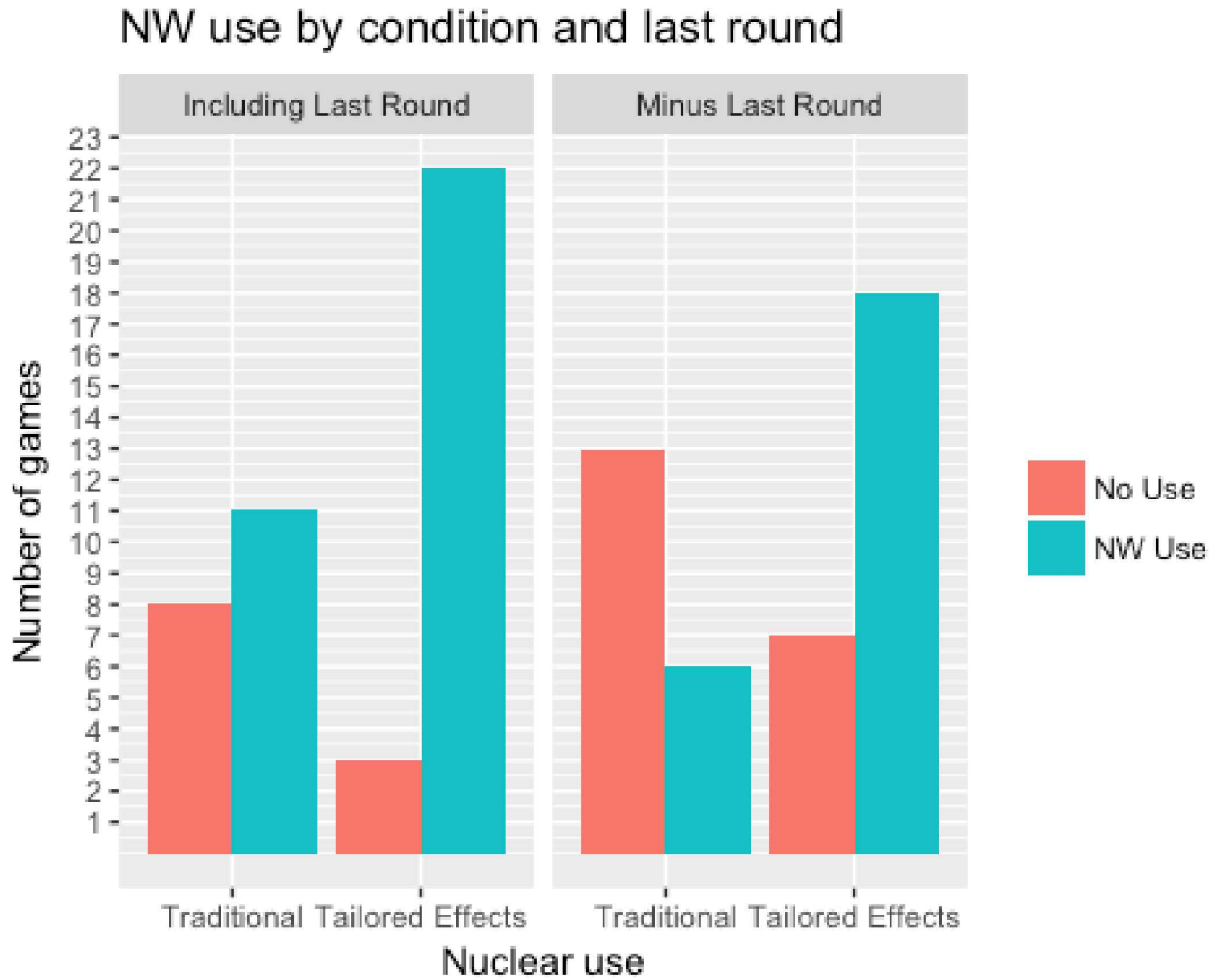
To answer our research question, we contrast games played with and without tailored-effects weapons



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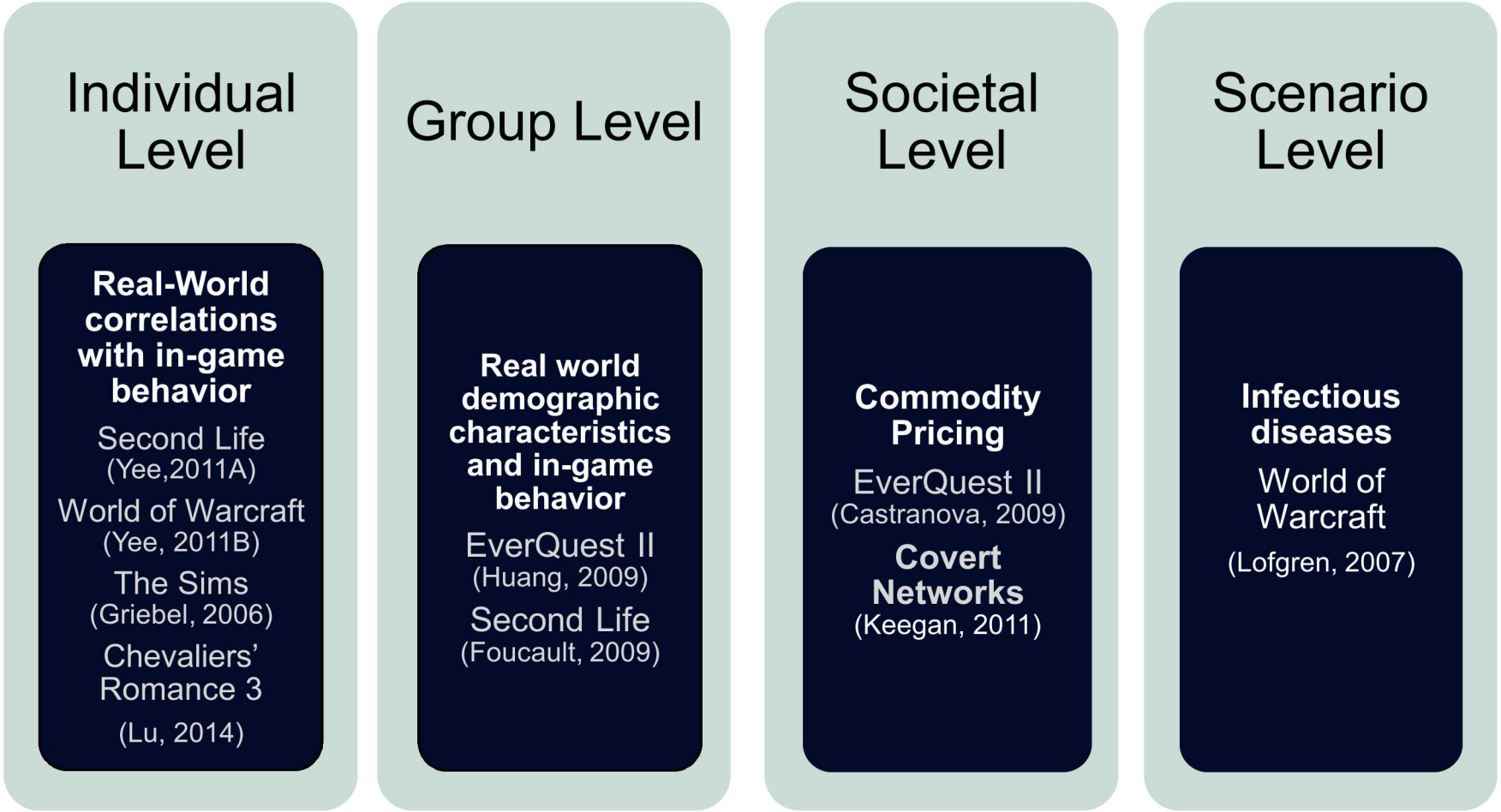
Correlations between the real world and games have been demonstrated in social science research:



Games are already used to study the real world