

## Studying Terrorism with Experimental Games

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This project consists of a series of laboratory experiments motivated by theoretical and policy issues related to terrorism. This study will test insights gained from game-theoretical modeling, and casual observation in controlled laboratory settings.

**Brief Description** - Experimental methods are a useful tool for the study of behavior in strategic situations or games, where each agent's payoff depends on decisions made by other strategic participants, whose behavior must be anticipated. While experimental games have been used in many economic contexts, their use in terrorism is very recent (see Hess, Holt, and Smith, 2007). Meanwhile game theorists and risk analysts have developed some interesting results and predictions about attacker-defender interactions motivated by terrorism and international conflict. In addition, testable insights about these interactions can be gleaned from tabletop, war-gaming, and simulation exercises. This project will explore the use of experimental games to test some of these emerging theories and predictions.

**Objectives** - The objective of this project is to test hypotheses about the behavior of actors (defenders, attackers) in selected terrorism contexts, using experimental games.

**Interfaces to other Center Projects** - This work will be closely linked to the game theoretic efforts at CREATE (Sandler, Bier). The risk analysis projects will also provide important inputs. The games will, in turn, provide a basis for developing web-based exercises that can be used for demonstrations and training at CREATE.

**Interfaces to non-Center Projects** - We expect significant collaborations with START in this project. We also anticipate some collaboration with the Intelligence Analysis Directorate of DHS and other divisions in formulating war tabletop exercises as a precursor to the design of some of the experimental games.

**Major Products and Customers** - The major results will be the outcomes of the tests of hypotheses about attacker-defender behaviors in experimental games in the terrorism context. These results will be important to validate or falsify some of the predictions made by recent theoretical models. Although behavior on both sides of this divide may be perceived as being random, explicitly randomized patrol strategies on the part of defenders will be evaluated in terms of their effectiveness against incursion decisions made by human participants in the experiments. Models of noisy learning and adaptive behavior of incursion decisions will be developed and used to inform more effective patrol strategies.

**Technical Approach** - Experimental games have been used successfully for several decades. In 2002, Vernon Smith won a Nobel Prize for his research in experimental economics, a prize shared with psychologist Danny Kahneman, for his insights into choices between risky prospects.

An experimental study consists of a series of interactions or “sessions,” in which participants are given roles of attackers, defenders, bargainers, etc. A typical session involves bringing participants into a laboratory setting, reading instructions, and letting participants make decisions, e.g. whether or not to invest in a measure that would deter a local terrorist attack. Payoffs depend on the person’s own decision and on the decisions of others, e.g. if damage from an attack can come from a “cross breach” (Kunreuther et al., 2008), or if local defensive measures merely shift the likelihood of an attack to other locations (Arce M., and Sandler, 2005).

Participants are financially motivated to make careful decisions, since they are paid in cash immediately at the end of a session. Earnings range from \$30 to \$50 for a 2 hour session. A typical study involves between 100 and 200 participants, depending on the number of treatments and group sizes. Participants are recruited in groups for two-hour sessions, to obtain independent observations. Each session would involve one or two treatments, with an unrelated exercise used to equalize earnings, build up earnings prior to possible losses, or to “clean the palette” between treatments when a sequence effect is anticipated. Each study involves 10-20 sessions, including some pilot sessions for testing and refining procedures. We are planning for about 170 subjects per study, who would each earn about \$40 on average (including show up fee and extra payments to alternates who are not used). Therefore, the total payment for human subjects is projected to be 4 (studies) times 170 (participants per study) times \$40, or approximately \$27,000. In one of the studies, we envision using groups of participants who have work experience in making strategic decisions. This study would use fewer subjects, with higher average earnings amounts. The sessions for this study may be done in a “field situation” using wireless laptop computers, and the budget contains some funds for acquiring inexpensive (factory refurbished) laptops for this purpose. Research assistants would be hired to assist in running the experiments, testing the software, recruiting subjects, etc.

Experiments can complement other forms of investigation; there is some loss of context in a laboratory setting, but this is offset by gains in control and replicability. Experiments are useful when motivated by theoretical work, e.g. the game theory that is often used in the study of terrorism and protective measures. Game theory involves assumptions of perfect rationality and foresight, but behavioral elements and bounded rationality are being increasingly incorporated into these theories, often guided by experimental insights about how people actually learn, behave, and adapt.

The project would also involve some refinement of relevant game-theoretic models to include noisy decision making, recency bias, and other behavior patterns that are observed in the experiments. This theoretical work would incorporate insights from probabilistic choice (e.g. logit) models, the quantal response equilibrium that integrates probabilistic choice into an equilibrium framework, and models of learning from experience and/or introspection that incorporate biases and notions of bounded rationality.

**Major Milestones and Dates**

Duration: July 1, 2008 to June 30, 2009, with a no-cost extension for final analysis and reporting.

- Design and pretest two experiments, July-September 2008
- Conduct two experiments, October-December 2008 One of the experiments will pertain to attacker/defender interactions, in which the defender strategies include patrols and inspections.
- Analysis and Draft Report, January 2008
- Design and pretest two experiments, February-March 2009
- Conduct two experiments, April-June 2009
- No-cost extension for Analysis and Report, and any subsequent experimental sessions needed to address issues that arise in the analysis stage., July-September 2009

**References:**

- Arce M., Daniel G. and Todd Sandler (2005) "Counterterrorism: A Game-Theoretic Analysis," *Journal of Conflict Resolution* 49(2), 183-200.
- Hess, Rachel O., Charles A. Holt, and Angela Smith (2007) "Coordination of Strategic Responses to Security Threats: Laboratory Evidence," *Experimental Economics*, 10(3), 235-250.
- Kunreuther, Howard, Gabriel Silvasi, Eric Bradlow, and Dylan Small (2008) "Deterministic and Stochastic Prisoner's Dilemma Games: Experiments in Interdependent Security," Discussion Paper, Wharton School.