Risk Perception

October 1, 2012 to September 30, 2013

Heather Rosoff
Richard John
University of Southern California
rosoff@usc.edu,
richardj@usc.edu

“This research was supported by the United States Department of Homeland Security through the National Center for Risk and Economic Analysis of Terrorism Events (CREATE) under Cooperative Agreement No. 2010-ST-061-RE0001. However, any opinions, findings, and conclusions or recommendations in this document are those of the authors and do not necessarily reflect views of the United States Department of Homeland Security or the University of Southern California.”

Cooperative Agreement No. 2010-ST-061-RE0001
Department of Homeland Security

December 31, 2013
ABOUT CREATE

Now in its tenth year of operation, the National Center for Risk and Economic Analysis of Terrorism Events (CREATE) was the first university-based Center of Excellence (COE) funded by University Programs of the Science and Technology (S&T) Directorate of the Department of Homeland Security (DHS). CREATE started operations in March of 2004 and has since been joined by additional DHS centers. Like other COEs, CREATE contributes university-based research to make the Nation safer by taking a longer-term view of scientific innovations and breakthroughs and by developing the future intellectual leaders in homeland security.

CREATE’s mission is to improve our Nation's security through research and development of advanced models and tools to evaluate risks, costs and consequences of terrorism and natural and man-made hazards and to guide economically viable investments in homeland security. We are accomplishing our mission through an integrated program of research, education and outreach that is designed to inform and support decisions faced by elected officials and governmental employees at the national, state, and local levels. We are also working with private industry, both to leverage the investments being made by the Department of Homeland Security in these organizations, and to facilitate the transition of research toward meeting the security needs of our nation.

CREATE employs an interdisciplinary approach merging engineers, economists, decision scientists, and system modelers in a program that integrates research, education and outreach. This approach encourages creative discovery by employing the intellectual power of the American university system to solve some of the country’s most pressing problems. The Center is the lead institution where researchers from around the country come to assist in the national effort to improve homeland security through analysis and modeling of threats. The Center treats the subject of homeland security with the urgency that it deserves, with one of its key goals being producing rapid results, leveraging existing resources so that benefits accrue to our nation as quickly as possible.

By the nature of the research in risk, economics, and operations, CREATE serves the need of many agencies at the DHS, including the Transportation Security Administration, Customs and Border Protection, Immigration and Customs Enforcement, FEMA and the US Coast Guard. In addition, CREATE has developed relationships with clients in the Offices of National Protection and Programs, Intelligence and Analysis, the Domestic Nuclear Detection Office and many State and Local government agencies. CREATE faculty and students take both the long-term view of how to reduce terrorism risk through fundamental research, and the near-term view of improving the cost-effectiveness of counter-terrorism policies and investments through applied research.

In 2011, the University of Southern California (USC) and a team of 23 partner institutions were awarded a new 5-year Cooperative Agreement resulting from a recompetition of the Center’s charter. This annual report covers the third year under Cooperative Agreement 2010-ST-061-RE0001, the ninth year overall of CREATE’s DHS funding, from October 2012 to September 2013.
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1. Risk Perception Overview

The objective of this research is to formulate a better understanding of how the public perceives the risk associated with disaster events (both terror and non-terror) and the influence this has on beliefs, risk perceptions, affect and behavioral decision making, both in the immediate and in the long-term.

During Year 9 we made progress by further developing scenario simulations designed to (1) identify the psychological factors that influence individual decision making, (2) study the actual decisions faced by U.S. residents following an event within the U.S., (3) assess both short- and long-term affective and cognitive reactions, as well as behavioral decision making in response to a disaster situation, and (4) develop from study findings policy recommendations that help the U.S. prevent, prepare and respond to disasters. Research progress and accomplishments made throughout Year 9 are described in the pages of this document.

Overall, we conducted 4 research experiments assessing decision making as it pertains to severe weather (tornados), cyber security (2 studies) and air travel (scenario involved an IED attack on an airplane). This work resulted in 5 peer-reviewed journal reports, 7 journal publications and 3 presentations at conferences.

2. Research Accomplishments

2.1. Year 9 Study 1: The impact of information specificity on behavioral responses to severe weather warnings following experiences with recent hits, false alarms and near

We conducted a follow-on experiment to the work completed during Year 8 that used scenario simulation to explore the decision making of residents in the event of severe weather warnings, specifically tornado warnings. The Year 9 study involved the development, implementation and results of a scenario simulation experiment that used video simulation of a series of location news reports to immerse respondents in the developing details of a series of tornado warnings in Oklahoma. The unfolding scenario was presented in discrete episodes, allowing us to track responses over the episodes and evaluate changes in affect, risk perceptions, beliefs about consequences and intended avoidance behavior.

We used a 4 (episode) by 2 (information) by 5 (outcome) design. Respondents were randomly assigned to one of ten conditions, defined by crossing two levels of information and five levels of outcome. Information and outcome were manipulated independent variables. The 2 information conditions were Doppler radar as the primary source for tornado information and advanced information sources for tornado information (e.g. National Weather Service products such as polygon warnings and Pathcast). The five severe weather event outcomes were a false
alarm, resilient near-miss, vulnerable near-miss, no-information control, and strike. The scenario simulation was designed to narrate through four video segments over a 24 hour period leading up to the occurrence of the severe weather event. All participants received the same first episode, and then the information manipulation was included in episodes two and three of the scenario. Episode four only included the outcome manipulation.

Participants for the study were recruited from members of the general public through Amazon Mechanical Turk over 2 times periods. The first wave was conducted in October 2012 and the second wave in July 2013. A total of 669 individuals participated in this experiment; 220 in October 2012 and 449 in July 2013.

Between the two time periods in which data was collected, Moore, Oklahoma was struck by a Category 5 (F5) tornado in April 2013. The occurrence of this severe weather event provided a natural experiment for assessing whether a recalled prior event and outcome increased survey participants’ negative affect, beliefs, perceived risks and avoidance behavior related to tornados.

To test this hypothesis, we ran a 2(episode – episodes 2 and 3) by 2 (information) by 2 (data collection time period) mixed factorial design. Results indicate that perceived risk, consequence (in terms of property damage and deaths and injuries) were greater for those participants who completed the survey during the second time period (after the tornado in Moore). In addition, this same group of respondents was more likely to seek shelter in the event of a tornado warning. This analysis presents preliminary evidence of how the interpretation of recent hazardous events influences future preventative actions.

A second analysis was conducted to explore whether variations in the outcomes of personal experiences influenced respondents’ negative feelings, beliefs about consequences, and avoidance behavior about future tornado warnings. We ran a between subjects ANOVA with one within subjects factor (five outcomes) assessed during one time period, episode four. As seen in Figure 1a, results indicate that negative affect about future tornado warnings are lowest for a false alarm and resilient near-miss, the two outcomes associated with no damage to the participants. Comparatively, negative feelings are elevated for the remaining three outcomes, of which the highest negative affect is associated with the control and strike conditions. In the context of affect, it appears that the lack of a known outcome in the control condition suggests that the participant assume the worse – the potential outcome is similar to that of a strike. Our findings further suggest in Figure 1b that intention to seek shelter in the event of a future tornado warning increases as the outcome becomes more severe (associated with personal consequences). That is, participants who were exposed to the control, vulnerable near-miss and strike outcomes were more willing to take protective action compared to the false alarm and near-miss conditions.
During Year 10, additional experiments are planned to be conducted with individuals and small groups who have had actual experience with tornadoes. This will allow the research team to further test the research design, particularly the policy implications of the information manipulation, validate our findings in an impacted population, and explore additional dependent variables and severe weather events of interest.

2.2. Year 9 Study 2: Heuristics and Biases in Cyber Security

During Year 9, a follow-up study to the experiment in Year 8 titled “Gain-loss Framing, Near Misses, and Cyber Security” was conducted looking at individuals’ behavior in response to cyber dilemmas – specifically with respect to the decisions participants would make following such an event. For this study, a cyber dilemma refers to the threat of causing serious damage to the respondents’ computer as a result of downloading a music file, installing a plug-in for an online game, and downloading a media player to legally stream videos.

The three cyber dilemmas were constructed to evaluate respondents’ risky choice behavior using one manipulated variable, recall of a friend’s false alarm, near-miss or hit experience. In addition, six individual difference variables were included in the design: sex, age, income, education, job domain, and self-reported victimization. Each participant received all three dilemmas in a constant order. Each of the three primed recall prior cyber experiences was paired with one of the three scenarios in a counterbalanced design such that each of the cyber dilemmas appeared in each of the three treatment conditions with equal frequency.

After each cyber dilemma, respondents were asked to respond on a 6-point scale (1=strongly disagree to 6=strongly agree) regarding their intention to ignore the warning and proceed with the riskier course of action. Following all three cyber dilemmas, respondents were given three attention check questions related to the nature of each dilemma. Respondents also were asked to provide basic demographic information and answer a series of questions about their experience with computers and cyber dilemmas, such as their experience with purchasing from a fraudulent online store, being locked out from an online account, or having unauthorized withdrawals made from their online banking account.
Three hundred seventy-six U.S. residents were recruited through Amazon Mechanical Turk (AMT) to participate in the experiment. Each respondent earned $1 for completion of the experiment. After removing respondents who did not answer all three of the attention check questions correctly or completed the experiment in less than seven minutes, the sample consisted of 247 respondents. Five additional respondents skipped questions, resulting in a final sample size of N=242.

Results show that the primed recall prior experience manipulation had a significant effect on how respondents intended to respond to the cyber dilemmas, F (1, 231) = 31.60, p <0.00, η^2= 0.12. This suggests that respondents who received a description of a friend’s near-miss experience recall preferred the safer, risk averse option compared to respondents who were primed to recall a friend’s prior false alarm experience. Respondents were found to be even more likely to select the safe option when they were primed to recall a friend’s prior hit experience.

The results of the ANOVA indicated there was a significant main effect for age: F (2, 231) = 4.9, p = .01, η^2= .04. Figure 2 suggests that younger respondents compared to older respondents were more likely to choose the riskier option in cyber dilemmas across all 3 levels of the primed prior recall experience manipulation.

Results also showed a significant interaction effect between income and the primed prior recall experience manipulation: F (2, 231) = 3.40, p = .01, η^2= .03. Figure 3 indicates that respondents with higher income levels (greater than $60K per year) were less sensitive to the primed recall of a friend’s experience.

![Figure 2. Mean endorsement of risky vs. safe responses to cyber threats by primed recall of friend’s prior experience and age.](image-url)
Figure 3. Mean endorsement of risky vs. safe responses to cyber threats by primed recall of friend’s prior experience and income level.

Also during Year 9, this study, coupled with the study from Year 8 titled “Gain-loss Framing, Near Misses, and Cyber Security”, was written up as an article and published in the journal *Environment, Systems and Decisions*.

### 2.3. Year 9 Study 3: Commercial Plane IED Attack experiment

During Year 9, data was collected for the Year 8 study titled “Commercial Plane IED Attack Experiment”. For this study, a video-based scenario was developed involving a terrorist attack on a commercial airplane with an improvised explosive device (IED). This was a 3 x 3 factorial experiment that involved systemic manipulation of event outcome (Interdicted in airport vs. Halted on plane while in progress vs. Detonated on plane) and attribute of outcome (Chance vs. Security System vs. Involved Person).

Subjects were first randomly assigned to one of the nine experimental conditions. Once participants finished watching their assigned videos, they were asked to respond to a number of questions about how they were feeling, perceived risk, likelihood of a successful attack, and their intentions to fly in the near future.

526 students from the USC Psychology subject pool completed the survey. Thirty percent (n = 158) subjects were male and 70% (n = 368) subjects were female. Because the majority of subjects were female, we included sex in the design to allow us to control for sex effect and to test the moderating effect of sex although sex was not distributed equally into nine experiment conditions.
A 3 Attack Outcome × 3 Causal Attribution × 2 Sex (Male v Female) factorial ANOVA was performed on positive and negative affect scores (PANAS). For positive affect, there was a significant main effect for Causal Attribution, $F(2, 512) = 6.00, \ p = .003, \ \eta_p^2 = .02$. Individual heroism subjects ($M_{\text{Heroism}} = 2.00$) experienced more positive affect than Countermeasure subjects ($M_{\text{Countermeasure}} = 1.85$), who in turn had higher positive affect than Luck subjects ($M_{\text{Luck}} = 1.71$). There was also a significant main effect for Sex, $F(1, 512) = 18.62, \ p < .001$, with a partial $\eta^2 = .04$. Males ($M_{\text{Male}} = 2.00$) reported higher positive affect than females ($M_{\text{Female}} = 1.70$).

For negative affect, there was a significant main effect for attack outcome, $F(2, 512) = 7.62, \ p < .001, \ \eta_p^2 = .03$. The worse the attack outcome, the more negative affect subjects experienced. There was also a main effect for causal attribution, $F(2, 512) = 6.59, \ p = .001, \ \eta_p^2 = .02$. Subjects in the Luck condition ($M_{\text{Luck}} = 2.97$) reported more negative affect than those in the Countermeasure condition ($M_{\text{Countermeasure}} = 2.66$), who in turn experienced more negative feeling than those in the Individual heroism condition ($M_{\text{heroism}} = 2.55$). Lastly, Sex had an effect on negative affect, $F(1, 512) = 16.38, \ p < .001, \ \eta_p^2 = .03$. Females reported higher negative emotions compared to males ($M_{\text{Male}} = 2.53$).

Attribution, Outcome, and Sex and three two-way interaction terms were entered into a binary logistic regression as simultaneous predictors of the dichotomous Fly vs. No Fly dependent variable. Figure 3 plots the effects of different attack outcomes and sex on subjects’ intention to fly. A test of the full model compared with a null model was statistically significant. The overall strength of these three variables to predict behavioral intentions to fly was modest, Nagelkerke’s $R^2 = .07$. Among the three predictors, Attack Outcome significantly predict subjects’ intention to fly, Wald $\chi^2(2) = 6.92, \ p = .03$. Particularly, the odds of not-flying for those who watched the interdiction video was 57.6% lower than the odds for those who watched the partial success video, $B = -.47, \ \chi^2(1) = 6.3, \ p = .01$. In addition, Sex was predictive of subjects’ intention to fly, $B = -.58, \ \chi^2(1) = 7.73, \ p = .005$. The odd of certain-to-fly for females were about 60% percent lower than the odd for males. However, Attributions only marginally predicted intention to fly, Wald $\chi^2(2) = 5.20, \ p = .074$. Planned comparison revealed a marginally significant difference in intention to fly between the countermeasure group compared to the luck and heroism groups, $B = .40, \ \chi^2(1) = 3.23, \ p = .07$. 
The experiment and results are currently in the process of being written up for publication in an academic journal. The research team has plans to have the article submitted to a scholarly journal before the end of 2013.

2.4. Year 9 Study 4: Hacker & Victim Type Influence on Cyber Security Decision Making

During the summer of Year 9 we conducted a second cyber security using the scenario simulation design to study public perceptions of an event after the event has occurred and impacted the survey participant. A bank letter notifying a cyber crime was developed to evaluate respondents’ responses using a 4 (hacker type) by 2 (victim type) factorial design. Each participant was randomly assigned to one of the eight conditions. The four hacker types were individual hacker, group hackers, unknown hacker, and individual hacker with a picture (ten pictures entered randomly), the two victim types were database and personal account. Subjects were presented with the bank notification reporting on the cyber attack. After reading the bank notification, subjects were asked to evaluate their present feelings, perception of the risks, threat beliefs, behavioral response, and attitude toward the government. Respondents were also asked to complete several psychological scales measuring neuroticism, domain-specific risk attitude, and spheres-of-control.

244 subjects were recruited from Amazon Mechanical Turk (AMT). 5 were removed by not answering the attention check question correctly. 239 subjects were included in the analysis.

Regressions were performed for six dependent variables regressed on one of the three contrast groups of hacker type, victim type, sex and age. Results indicated that subjects’ negative feelings toward an individual hacker was significantly different than that for an individual hacker with a picture (beta = .135, t = 2.088, p = .038). Subjects experienced less negative affect with the individual hacker and picture. In addition, subjects’ positive affect significantly differed by attack type (beta = .143, t = 2.275, p = .024) such that subjects experienced more positive affect if their personal account was hacked. There was also a significant interaction between hacker type (individual vs. individual with picture) and victim type for the intention to continue service (beta = .137, t = 2.106, p = .036). Participants were more willing to continue service when the bank database was hacked compared to the personal account attack for an individual hacker.
However, if the individual hacker was accompanied by a picture, the participants were more willing to continue service when their personal account was hacked. Figure 4 displays the mean negative affect, positive affect and agreement to continue service for different hacker types and victim types.
Figure 4. Mean negative affect, positive affect, intention to continue service for hacker types and victim types

During Year 10, we plan to submit the results from this study for publication in a scholarly journal.

2.5. Research Products

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<tr>
<th>Research Product Metrics</th>
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</tr>
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<tr>
<td># of peer-reviewed journal reports accepted for publication</td>
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</tr>
<tr>
<td># of non-peer reviewed publications and reports</td>
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<td># of scholarly journal citations of published reports</td>
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<tr>
<td># of scholarly presentations (conferences, workshops, seminars)</td>
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</tr>
<tr>
<td># of outreach presentations (non-technical groups, general public)</td>
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</tr>
</tbody>
</table>

2.5.1. Publications


2.5.2. Presentations

John, R. S., Dillon, R. & Rosoff, H. Do near misses impact reference points to produce risk seeking behavioral responses to warnings? Decision Analysis Society sponsored presentation at the annual meeting for the Institute for Operations Research and Management Science (INFORMS), Phoenix, Az., October 14-17, 2012.


3. Research Transition

Public perceptions of terrorism risk already have been recognized by the TSA as valuable input in calculating the indirect costs of transportation-related terrorism events. CREATE in collaboration with Decision Research has received funding and completed a project for the TSA using the scenario simulation approach. In our recently completed project, CREATE researchers used scenario simulation to assess the how risk communication could be used to prevent airline losses following an attack.

We are planning to continue our relationship with the TSA, as well as pursue a new relationship with FEMA. Meetings are scheduled with both departments in early December 2013 in Washington D.C.

4. Education and Outreach Products

<table>
<thead>
<tr>
<th>Education Initiatives (Please detail below)</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td># of students supported (funded by CREATE)</td>
<td>4</td>
</tr>
<tr>
<td># of students involved (funded by CREATE + any other programs)</td>
<td>7</td>
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<tr>
<td># of students graduated</td>
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<tr>
<td># of student theses or dissertations</td>
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<tr>
<td># of contacts with DHS, other Federal agencies, or State/Local (committees)</td>
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<td># of existing courses modified with new material</td>
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<tr>
<td># of new courses developed</td>
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<td># of new certificate programs developed</td>
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<tr>
<td># of new degree programs developed</td>
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</tbody>
</table>


**Funded by CREATE**

Tracy Cui, M.S., Ph.D. program, Department of Psychology, Dornsife College of Letters, Arts, and Sciences
Hoang Nguyen, Ph.D. program, Department of Psychology, Dornsife College of Letters, Arts, and Sciences
David Judge, Master of Public Administration Program, Sol Price School of Public Policy
Yehudit Schutzman, Master of Public Administration Program, Sol Price School of Public Policy

**Other**

Adam Syed, Undergraduate Student, USC
Josh Greenberger, Undergraduate Student, USC

**Summer Student:**

Lauren Ladd-Reinfrank, Summer Intern

5. **Outreach**

The relationship with the TSA, thus far, has been managed by Isaac Maya and William Burns. In meetings in December, CREATE researchers plan to establish more direct lines of communication with the TSA and FEMA.