Available online at www.sciencedirect.com
ScienceDirect
Journal of Experimental Social Psychology 43 (2007) 168–179
Journal of Experimental Social Psychology
www.elsevier.com/locate/jesp

"To eat or not to be eaten?" Collective risk-monitoring in groups ☆

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Received 3 November 2004; revised 2 September 2005
Available online 29 March 2006
Communicated by Stasser

Abstract

The importance of risk-monitoring has been increasing in many key aspects of our modern lives. This paper examines how individuals monitor such risks collectively by extending a behavioral ecological model of animal foraging to human groups. Just as animals must forage for food under predatory risk, humans must divide valuable material and psychological resources between foraging activity and risk-monitoring activity. We predicted that game-theoretic aspects of the group situation complicate such a trade-off decision in resource allocation, eventually yielding a mixed equilibrium in a group. When the equilibrium is reached, only a subset of members engage in the risk-monitoring activity while others free-ride, concentrating mainly on their own foraging activity. Laboratory groups engaging in foraging under moderate risk provided a support to this prediction. When the risk-level was set higher, however, "herding behavior" (conforming to the dominant behavior) interfered with the emergence of equilibrium. Implications for risk management are discussed.

Keywords: Risk-monitoring; Foraging; Cooperation; Free-riding; Producer-scrounger game; Uncertainty; Information cascade; Behavioral ecology

Introduction

Most modern risks are collective in nature, affecting many people's lives simultaneously. Fragile financial markets, moral hazards in international business, and pollution by toxic substances are all examples of risks that affect many people at the same time. Anecdotes abound that insufficient monitoring of these collective risks can cause serious, sometimes unrecoverable damages to a large human population (Reason, 1997; Slovic, 1987, 1999). On the other hand, despite the importance of the problem to modern societies, few psychological studies have addressed how such risks are monitored collectively. In this paper, we examine how people monitor collective risks in a group setting, focusing on the potential free-rider problem in risk-monitoring. Our theoretical perspective is adaptationist or game-theoretic (cf. Hastie & Kameda, 2005; Kameda & Hastie, 2004; Kameda, Takezawa, & Hastie, 2003, 2005). Specifically, we extend a behavioral ecological model of animal vigilance and foraging to human groups under risk, and test predictions derived from the game-theoretic model via an interactive, laboratory experiment.

Risk-monitoring as a key element in modern societies

Studies of risk in psychology have been developed on several major themes. One central theme concerns the elaboration of the notion of risk in judgment and decision-making (Kahneman & Tversky, 1979; see Dawes, 1998; Hastie, 2000 for reviews). Researchers in this field have formally refined the notion of risk, yielding important empirical results about its functioning in individual and group decision-making (e.g., Davis, Kameda, & Stasson, 1992;

☆ This research was supported by the Grant-in-Aid for Scientific Research 17330133 from the Ministry of Education, Culture, Sports, Science and Technology of Japan to the first author. We are grateful to Reid Hastie, R. Scott Tindale, Paul Wehr, Robin M. Cooper, Andreas Wilke, Keiko Ishii, Taiki Takahashi, Takafumi Tsukasaki, Daisuke Nakama, and Yoshihisa Nakayama for their helpful comments on an earlier version of the manuscript.
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0022-1031/$ - see front matter © 2006 Elsevier Inc. All rights reserved.
doi:10.1016/j.jesp.2006.02.003

Kameda & Davis, 1990; Loewenstein, Weber, Hsee, & Welch, 2001). Another key theme is concerned with risk perception and communication (Fischhoff, Lichtenstein, Slovic, Derby, & Keeney, 1981; Slovic, 1987). Researchers have identified various factors affecting people's perception of risk, and have examined the ways to facilitate effective communication between experts and lay people about technological or policy issues involving risk (Fischhoff, 1995; Slovic, 1999).

Along with other applied work on health risks (cf. Adler, Kegeles, & Genevro, 1992), these developments have greatly contributed to our understanding of human behavior involving various risks. Yet, there seems to be one glaring omission in previous psychological research, despite its theoretical and practical significance—the study of risk-monitoring. An episode in international business may help to illustrate the increasing importance of risk-monitoring in modern societies. In February 1995, Britain's Barings bank, the oldest merchant bank in the country, collapsed due to the actions of a single trader based at a small office in Singapore. In just 3 years, the trader, Nick Leeson, caused a huge, irrevocable loss to the entire group, amounting to nearly 870,000,000 GBP through a series of unauthorized trades involving "error accounts." The most problematic aspect of this episode was that the trader's harmful actions were largely unmonitored. Even though some of the auditors at the Barings Group reported suspicious activity, concerns were largely unheeded at the head office in London, which was occupied with "other more urgent business"; they failed to systematically redirect their resources so as to monitor the potential risk at the Singapore branch (for details, see <http://www.riskglossary.com/articles/barings_debacle.htm/>, and Reason, 1997).

As illustrated in this example, insufficient risk-monitoring in a group can cause serious consequences, involving the demise of an entire group or population. Toward a better understanding of risk-monitoring behavior, we approach this issue from an adaptationist perspective (cf. Kameda & Hastie, 2004; Kameda & Tindale, 2004), exploring the applicability of a behavioral ecological model of animal vigilance to human groups.

Behavioral ecological models of animal vigilance

Although we tend to think of "risk" in humanistic terms, the notion applies to the entire animal kingdom. Recently, scholars have made attempts to link theories of risk developed in the social sciences (applied mostly to humans) to theories developed in behavioral ecology (Weber, Shafir, & Blais, 2004).

Behavioral ecology has yielded sophisticated models and empirical data concerning risk-monitoring in the animal kingdom (cf. Krebs & Davies, 1993, 1997). According to these models, the lives of many animal species are divided between foraging for food and avoiding predation by other animals. These two activities are often mutually exclusive—extra effort in one reduces the effort available to the other. Therefore, when an animal forages for food, it must divide its time and attention between feeding and being vigilant for predators. Notice that, as illustrated in the demise of the Barings Group, humans in modern, as well as in primordial societies, constantly face the same adaptive challenge, to strike a balance between foraging/intake activity and risk-monitoring.

The behavioral ecology literature suggests that many animals' behavior under such a trade-off may be approximated by a cost-benefit model (Lima, Valone, & Caraco, 1985; Milinski & Heller, 1978). Laboratory experiments and field observations of many species (some rodents and birds, for example) suggest that, if the animals live solitary lives, individual optimization models essentially approximate their allocation decisions. The times allotted for being vigilant and feeding yield approximately a maximum joint fitness to the individuals most of the time (see Houston, McNamara, & Hutchinson, 1993, for general results about the trade-off between gaining energy and avoiding predation).

On the other hand, game-theoretic aspects complicate allocation decisions for social species (Pulliam, Pyke, & Caraco, 1982). Often, animals that forage together can enjoy "aggregation economies", or benefits associated with grouping that are unavailable to solitary foragers. In a group, there are many more eyes to watch for predators, allowing each animal to devote a relatively greater proportion of their time to foraging for food. However, it is exactly these features that yield an incentive for free-riding—If there are already a sufficient number of watchers engaged, why should not one choose to forego vigilance and forage exclusively. Giraldeau and Caraco (2000) named such an interdependent structure (including the vigilance-foraging situation) a "producer-scrounger" game. In the producer-scrounger game, if there are many "producers" of public (or collective) goods that are beneficial to others as well as oneself (e.g., monitoring for predators), each individual is better off exploiting the efforts of others (e.g., eating 100% of the time). However, if there are too many "scroungers" on another's monitoring efforts, each individual is better off switching to producing. If no one serves as a watcher, the gain from one's own risk-monitoring exceeds its cost; under these circumstances, reducing the likelihood of predation is a better option than eating.

Notice that, in contrast to the social dilemma game (Dawes, 1980), defection is *not* a dominant strategy in the producer-scrounger game. The net benefit of one strategy is not fixed (i.e., neither strategy is dominant), but depends on the frequency of the alternative strategy within the group; too many players opting for one strategy simultaneously reduces its profitability while increasing that of its alternative, providing an incentive for individuals to switch. Since the two strategies are mutually constrained in terms of profitability, we can expect a mixed Nash equilibrium to eventually emerge (Gintis, 2000; Maynard Smith, 1982). At equilibrium, the group reaches a stable