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What makes risk acceptable? Revisiting the 1978 psychological dimensions of perceptions of technological risks

Katherine T. Fox-Glassman, Elke U. Weber *

Columbia University, United States

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ABSTRACT

The complex nature of perceived risk and the influence of perceived risks and benefits on risk acceptability or risk taking have been analyzed in multiple ways. R. Duncan Luce made important contributions to both normative and descriptive models of quantitative definitions of risk and risk acceptability, concentrating on the effects of possible outcomes and their probability. Fischhoff, Slovic, and Lichtenstein, in contrast, assessed a set of qualitative and affective dimensions of perceived technological and social risk and analyzed their effects on perceived risk and risk acceptability. The current research presents a minimally modified replication of their 1978 study, eliciting risk perceptions from a diverse group of US residents. After almost 40 years, we find a pattern of rank-ordered risk perceptions that remains practically unchanged, and is still explained by two factors: dread and uncertainty. We find, however, that today dread risk shows a greater influence than it did in the original study, and now reflects stronger contributions of the voluntary and uncontrollable risk characteristics. We end by reflecting on the mutual impact of different types of risk research and point out promising future research directions.

Throughout his career, R. Duncan Luce took a strong interest in risky decisions, from modeling risk taking early on (Luce & Raiffa, 1957) to later axiomatizing subjective perceptions of risk (Luce & Weber, 1986). Most recently he proposed a *p*-additive utility theory (Luce, 2010a,b) with three distinct representations that correspond to averse, neutral, or seeking risk attitude. Davis-Stober and Brown (2013) extended this work by allowing that decision makers may not have an invariant risk attitude across different situations.

The conjoint-expected-risk (CER) axiomatic model of perceived risk makes risk a more complex construct than variability of outcomes, allowing probabilities of gains or losses to affect perceived risk directly and allowing for a differential effect of upside and downside variability, with potential individual, group, or situational differences in the weight of these components on perceived risk (Luce & Weber, 1986). Weber, who developed the CER model with Luce, has modeled the subjective nature of risk in multiple other ways. A risk–return framework generalized from Markowitz (1952) – where people's willingness to pay (WTP) for risky option X is a tradeoff between the option's expected value (return) and variance risk – allows for return and risk estimates not necessarily equal to the moments of the outcome distribution or even measured on quantitative scales (Weber & Milliman, 1997). Here risk attitude determines the trade-off between risk and return:

$$\text{Risk Taking} = f(\text{Perceived Return, Perceived Risk, Risk Attitude}). \quad (1)$$

For example,

$$\text{WTP}(X) = V(X) - bR(X), \quad (2)$$

where b describes the tradeoff between the maximization of return and minimization of risk and measures a person's risk attitude. Factors such as familiarity which will vary between choice domains, often moderated by demographic factors such as gender or age, have been shown to influence perceptions of risk and of benefits (see Figner & Weber, 2011, for a recent summary).

In their domain-specific risk-taking (DOSPERT) framework, Weber, Blais, and Betz (2002) employed the same decomposition of risk taking (RT) as a tradeoff between perceived risks (PR) and perceived benefits (PB) of risky choice options:

$$\text{RT}(X) = \text{PB}(X) - b\text{PR}(X), \quad (3)$$

to account for domain-variant risk taking while still allowing for a domain-general individual difference risk-attitude parameter, b.

Domain-specific differences in risk taking, from recreational choices to financial, social, health/safety, and ethical decisions, can

* Corresponding author. Tel.: +212 663 6212.
E-mail address: euw2@columbia.edu (E.U. Weber).

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be explained by domain-specific differences in perceived risk (Weber et al., 2002) or perceived benefits (Hanoch, Johnson, Wilke, 2006). In addition, risky decisions also differ by the degree to which they involve "hot" affective processes or "cold" deliberative processes (Figner, Mackinlay, Wilkening, & Weber, 2009). "Risk as feelings" is a sufficiently widespread phenomenon to be the title of a widely-cited review paper (Loewenstein, Weber, Hsee, & Welch, 2001). Analytic consideration of risk has a long history and are captured in a normative fashion by the variance of outcomes in the risk–return models of finance and in a descriptive fashion by the CER model and the psychological risk–return framework. It is worth noting that emotional or affective considerations of risk were already examined and identified by Fischhoff, Slovic, Lichtenstein and colleagues in the 1970s, even if not explicitly presented in this light, and thus preceded the emotions revolution of the 1990s by a couple of decades.

Most if not all activities in everyday life carry some risk of harm. Driving a car could lead to a crash, taking a prescription antibiotic might cause unpleasant side effects, and living near a nuclear power plant increases the chances of radiation exposure. Different technologies vary both in their probability of causing death or injury and in the benefits they offer to society to make up for those costs—but they vary on many other dimensions as well, and these other dimensions may carry much more weight when it comes to our judgments about how risky different technologies seem or feel. For example, although many more people are killed or injured every year in car crashes than by nuclear power, the latter still often feels more unsafe.

In their 1978 paper "How Safe is Safe Enough?", Fischhoff, Slovic, Lichtenstein, Read, and Combs employed a psychometric analysis to model and help explain why different technologies and activities might inspire such different risk reactions. Taking the position that risk can vary across many characteristics—How immediately do the effects take place? How many people are affected at once? How controllable do the consequences feel?—Fischhoff et al. showed that perceptions of risk for everyday activities and technologies tend to load onto two orthogonal dimensions, which they called dread risk and unknown risk. Dread risk appeared to relate to consequences that are likely to be catastrophic, that are certain to be fatal, and that feel dreaded on a gut level. Unknown risks were those that are new, that are undertaken involuntarily, whose consequences are delayed, and which seem not fully known to science or to those exposed (Fischhoff, Slovic, Lichtenstein, Read, & Combs, 1978). In later studies, similar sets of characteristics were found to load onto these factors: dread risk encompassing lack of control, catastrophic and fatal effects, a feeling of dread, and an imbalance in the distribution of risks and benefits; and unknown risk being associated with consequences that are unobservable, new, delayed, and unknown to science and the exposed (e.g., Slovic, 1987; Slovic, Fischhoff, & Lichtenstein, 1985, 1986).

Since the 1980s, hundreds of studies have cited the concepts of dread and unknown risk to illuminate risk perception on topics ranging from avian flu (Gstraunthaler & Day, 2008) to genetically modified foods (Gaskell et al., 2004), to financial decisions (Koonce, McAnally, & Mercer, 2005). Other studies have investigated risk perception cross-culturally using Fischhoff et al.'s (1978) framework in countries such as Norway (Teigen, Brun, & Slovic, 1988), Hungary (Englander, 1986), and Korea (Cha, 2000). However, little work has shown how perceptions of risks for everyday technologies and activities have changed (or not) over the past three decades, aside from studies looking at relatively specific domains (e.g., a study of food-related hazards by Sparks & Shepherd, 1994).

We therefore have little idea of how risk perceptions or attitudes may have shifted over time. Since the 1980s, the objective risks of many of the 30 items that Fischhoff et al. (1978) studied have in fact changed, as have the media culture and public knowledge about these risks. New technologies have emerged during the intervening decades, bringing new risks to public awareness and likely influencing public opinion about older technologies. Between the emergence of the 24-hour news cycle in the 1980s, the rise in awareness of global terrorism in the United States since 2001, and the information-sharing culture encouraged by social networking, it is reasonable to expect changes between 1978 and today in terms of the psychological availability of various social and technological risks, as well as the public's knowledge about and attitudes toward those technologies.

The goals for this study were to replicate Fischhoff et al.'s 1978 study, and to offer a descriptive look at how risk perceptions for a set of 30 activities and technologies have appear to have changed over the past several decades. While we did not expect that people today would show the same risk perceptions for those 30 items as people did in the 1970s, we did believe that the two-factor expressed preference framework that Fischhoff and colleagues developed would still be effective today to illustrate and partially quantify those perceptions of risk.

1. Method

We matched the design and content of this study as closely as possible to Fischhoff et al. (1978), referred to hereafter as FSLRC78. There are, however, two differences in method between the current version of the study and the original one: one in elicitation medium (now online vs. before on paper) and the other in participant population (now a diverse US sample vs. before Oregon League of Women Voters members and their husbands).

1.1. Design

Following FSLRC78, Ps evaluated 30 activities and technologies on multiple dimensions: (1) the technology/activity's perceived benefit (risk) to society; (2) the acceptability of the technology/activity's current level of risk; and (3) its placement on each of nine dimensions of risk. The first part of the study was varied between Ps: some judged only the perceived benefit of each activity or technology, while others judged only the perceived risk. All Ps then answered the same questions in Parts 2 and 3.

The list of 30 activities/technologies for Ps to judge was copied exactly from Fischhoff et al., and can be seen in Table 1. For each task in the study, the order in which the 30 activities/technologies appeared was counterbalanced in a blocked Latin square design: five blocks of six items each were shuffled so that each activity/technology appeared early in the list for some Ps, in the middle of the list for others, and at the end of the list for others. No order effects were detected, so order will not be discussed below.

Matching the instructions used by FSLRC78, our Ps were told before they began their evaluations that "This is a difficult, if not impossible, task. Nevertheless, it is not unlike the task you face when you vote on legislation pertaining to nuclear power, handguns, or highway safety. One never has all the relevant information; ambiguities and uncertainties abound, yet some judgment must be made. The present task should be approached in the same spirit".

1.2. Tasks

1a. **Perceived benefit**. Participants in the *benefits* condition were asked to judge the benefits to society of each of the 30 activities or technologies. For each, Ps were asked to "consider all types of benefits: how many jobs are created, how much money is generated directly or indirectly (e.g., for swimming, consider the manufacture and sale of swimsuits), how much enjoyment is