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Risk Perception

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Introduction

Natural hazards, health hazards, terrorist attacks, new technologies, transportation—all of them represent risks in our life. We face some of these risks daily, others rarely, if ever. Some risks constitute a threat to individuals, some to the entire society. We overestimate some risks, while underestimating others. Some risks trigger a strong emotional response, others are perceived more "cold" and rational.

In this chapter, we start with a definition of the concept of risk and how it differs from the concept of uncertainty. We then outline major theories, models, and mediators that influence our perception of risk. Although the models stem from different research programs, highlight different mechanisms, and are often discussed in isolation from each other, they serve as psychological explanations for how we perceive risks in our daily life.

Defining Risk and Risk Perception

Risk is a highly interdisciplinary concept and its measurement differs across and even within disciplines. For instance, in a health context, risk can refer to the number of fatalities, which can be measured through the probability of death, expected life-years lost, deaths per person exposed, or total deaths (Fischhoff, 2009, p. 943). More generally, most definitions of risk have in common that risk comprises two factors: (1) the probability of harm and (2) the magnitude of harm, where harm refers to threats to humans and things they value (Hohenemser, Kates, & Slovic, 1985). In this sense, risks are measureable and risky situations are conditions in which outcomes (i.e., the harm) and probabilities are known. For instance, one can access the risk of losing in the casino, the risk of an adverse event of a specific treatment, or the risk of a car accident for a given population. Risky situations have to be distinguished from uncertain situations that are conditions in which either both, the outcomes and probabilities, or at least the probabilities are unknown (see Meder, Le Lec, & Osman, 2013). This distinction goes back to Knight (1921) who defined uncertainty as immeasurable in contrast to measureable risks. However, more recent approaches broaden the definition of uncertainty as they consider probabilistic parameters such as standard deviations, expert confidence ratings, or ranges as (quantifiable) indicators of uncertainty (e.g., Politi, Han, & Col, 2007). Throughout this chapter, we mainly refer to risks, that is, situations in which outcomes and probabilities are measureable. Furthermore, when talking about uncertainty, we mean that probabilities are not measureable, and we use the term *ambiguity* to designate situations in which probabilistic parameters are used to quantify uncertainty of risk estimates.

Risk perception refers to the "subjective assessment of the probability of a specified type of accident happening and how concerned we are with the consequences" (Sjöberg, Moen, & Rundmo, 2004, p. 8z). Pidgeon, Hood, Jones, Turner, and Gibson (1992) defined risk perception as "people's beliefs, attitudes, judgments and feelings, as well as the wider social or cultural values and dispositions that people adopt, towards hazards and their benefits" (p. 89) and thereby stressed that risk perception is not simply an individual process but has to be understood against the societal and cultural background (see also Kasperson, Kasperson, Pidgeon, & Slovic, 2003).

Furthermore, evaluating a risk from different perspectives has different implications for the evaluation of such a risk, as well as consequences for behavior. Imagine a woman who knows that of 100,000 women like her, 15 will have cervical cancer. She might decide not to participate in prevention, such as screening with a pap smear (a test to identify early stages of cervical dysplasia), because her baseline risk is rather low. Now imagine a health policy maker: Pap smear screening reduces the annual incidence of cervical cancer in Germany by a total 10,400 women. In this case, a national program to implement pap smear screening might be appreciated (example from Neumeyer-Gromen, Bodemer, Müller, & Gigerenzer, 2011). Thus, depending on whether a policymaker or an individual layperson decides about the screening, the benefit will be evaluated differently.

Social and Cultural Components of Risk Perception

Although the focus of this chapter is on risk perceptions of individuals, it is important to remember that risk perception always takes place in a social and cultural context (see Part I, Section 2). The social amplification of risk framework is an integrative model of risk perception that is grounded on the assumption that "risk . . . is not only an experience of physical harm but the result of processes by which groups and individuals learn to acquire or create interpretations of risk" (Kasperson et al., 2003, p. 13). Hence, risk perception has to be understood as a communication process along a chain from the sender to the receiver, with different stations in between that may amplify or attenuate risks. Such stations can be social (e.g., news media), individual (e.g., attention filter), or institutional (e.g., political and social actions).

The way we perceive and react to risks is further shaped by our values. In their cultural theory of risk, Douglas and Wildavsky (1983) distinguished between different cultural worldviews. The major dimensions are individualism (e.g., defending individual freedom) versus communitarian (e.g., supporting collective action) and hierarchical (e.g., leaving important decisions to experts) versus egalitarian (e.g., striving for equality). For instance, people with hierarchical–individualist worldviews value markets and commerce and feel uneasy when these activities are restricted. On the other hand, people with egalitarian–communitarian worldviews are ambivalent about markets. The interaction of personal values and risk perception idea is also implemented in the cultural cognition of risk thesis.

The Psychometric Paradigm

One of the earliest and most influential models in risk perception is the psychometric paradigm (Slovic, 1987). Based on the assumption that risks are quantifiable and predictable, the psychometric paradigm uses psychophysical scaling and multivariate techniques to explain laypeople's reactions to hazards. In their seminal study, Fischhoff, Slovic, Lichtenstein, Read, and Combs (1978) asked participants to rate 30 activities and technologies (e.g., fire fighting, nuclear power, pesticides, motor vehicles, smoking, food coloring) on nine different dimensions they had previously identified in the literature: (1) voluntariness of risk, (2) immediacy of effect, (3) knowledge about risk by scientist, (4) knowledge about risk by exposed person, (5) control over risk, (6) newness, (7) catastrophic potential, (8) dreadfulness, and (9) severity of consequences. Each dimension was assessed on a 7-point scale. A factor analysis based on the correlation of the mean ratings revealed two orthogonal factors: dread risk and unknown risk (sometimes called novelty). High dread risk means that perceived lack of control, dread, and catastrophic potential and fatal consequences are high (e.g., nuclear reactor incidents); high unknown risk means that the hazard is unobservable, unknown, new, and delayed (e.g., chemical and DNA technologies; Slovic, 1987). Note that unknown risk is different from uncertainty and ambiguity as defined above, as unknown risk is a psychological construct and refers primarily to the fact that the risk is novel, yet it could, in theory, be objectively quantified. The two factors (dread and unknown risk) have been observed in various studies across countries to predict laypeople's reactions to hazards and have therefore been assumed as robust across different cultures and environments (Boholm, 1998; Slovic, 2000). The factor dread risk was found to better predict laypeople's risk perception and desire for risk regulations compared with the factor unknown risk (Slovic, 1987). It is important to keep in mind that the model was primarily intended to explain risk perception in laypeople, because they give relatively little weight to actual risk assessment (Covello, von Winterfeldt, & Slovic, 1987). Experts, in contrast, defined risks strictly in terms of annual fatalities, at least, according to findings from the psychometric paradigm on small expert samples (Slovic, Fischhoff, & Lichtenstein, 1979).

The psychometric paradigm is not without its critics (Sjöberg, 2002b, 2003). For instance, the model primarily predicts risk perception on an aggregated level—that is, using average ratings across participants and across hazards. In this case, up to 80% of the variance of perceived risk can be explained with the two factors, however, if one considers only one specific hazard each time the explained variance drops to about 20% (Gardner & Gould, 1989; Sjöberg, 1996, 2002b). Hence, the original aggregated analysis of perceived risk in the psychometric paradigm does not give information about individual variation as well as intraindividual perceptions across different hazards. Sjöberg (2002a) challenged the assumption that experts differ in their underlying processes and assess risks via annual fatalities only. In fact, he found that experts' and laypeople's risk perceptions were rather similar. However, one possible explanation is that laypeople and experts follow different definitions of risk, as experts primarily refer to an objective, numerical assessment, whereas laypeople are more affect driven (Slovic, 1999). In sum, the psychometric paradigm has been an influential model for describing risk perceptions and has yielded important insights and impulses. At the same time, its application to predict individual risk perception is limited and it does not provide a process model that explains the cognitive mechanisms underlying risk perception.

Dread Risk: The Role of the Social Circle

As proposed by the psychometric paradigm, dread is an important predictor in people's perception of and reaction to hazards. The dread hypothesis further proposes that people have a strong tendency to avoid risks that kill many people at once, compared with risks that cause the same number of fatalities over a longer period of time (Slovic, 1987). For instance, the terrorist attack of 9/11 represents a dread risk. As a consequence of the attack, many people avoided airplanes and switched to cars instead, which increased fatalities in car accidents (Gaissmaier & Gigerenzer, 2012; Gigerenzer, 2004, 2006). At the same time, the fact that between 44,000 and

98,000 patients die in the United States annually due to preventable medical errors is not perceived as a dread risk. At least four possible explanations can account for the fact that people tend to fear dread risks more than continuous risks, even if both cause the same number of fatalities (Galesic & Garcia-Retamero, 2012; Gigerenzer, 2006). First, dread risks are perceived as less controllable. The findings from the psychometric paradigm suggest that lack of control loads highly on the factor dread risk (Slovic, 1987). Whereas we may assume high control when driving, which yields in low risk perception, we may assume low control over earthquakes and terrorist attacks, which yields in high risk perception. Second, people are not aware of the actual underlying statistical information. In particular, knowledge about continuous, everyday risks may be underestimated as they are less salient compared with dread risks that, in turn, may be overestimated. Third, from an evolutionary perspective, an event killing many group members once imposed a substantial threat to the survival of the group when still living in hunter–gatherer societies. Hence, people might be prepared to fear particularly those risks that threaten survival of their group. Galesic and Garcia-Retamero (2012) examined this hypothesis and tested to what extent risks that affect a number of people corresponding to the typical size of our social circle (e.g., family, friends) are perceived as more relevant. They defined the social circle as a group of up to 200 people. Results of nine experiments consistently showed that people perceived a risk killing 100 people as more dreadful and frightening than a risk killing 10 people. However, a risk killing 1,000 people was rated equal to a risk killing 100 people, suggesting that the number of people corresponding to the social circle is crucial in defining the dread potential and related fear. Fourth, and related, is the finding that dread risks have a stronger impact on the population size over time than continuous risks causing the equivalent number of fatalities (Bodemer, Ruggeri, & Galesic, 2013). The reason is that a fatal event strikes twice: (1) it kills a number of people immediately and (2) it reduces the number of future offspring by reducing the number of their potential parents. Hence, a risky event that kills young people—potential parents for future generations—strongly influences population size. Due to the fact that dread risks kill many people once and often affect younger generations also, it takes longer for the population to recover from dread risks than from equivalent continuous risks.

The Role of Affect: Risk-as-Feelings and the Affect Heuristic

Affective reactions provide important signals about how we perceive and "feel" about our environment (see also Chapter 3, this volume). Affect emerges automatically and quickly, often before a cognitive and conscious evaluation of the situation takes place. Affective reactions allow evaluation of the target, guide what information we search for and focus on, motivate behavior, and allow comparison of different events and situations on a common level (Peters, 2006). Risks can trigger emotions in two dimensions: (1) immediate emotion, when one is confronted with the risk as integral emotions that are caused by the risk itself or incidental emotions that are caused by other, unrelated factors yet influence risk perception, and (2) anticipated emotions, which are expected to be experienced in the future.

Two major approaches have been proposed to study the role of affect in risk perception. The risk-as-feelings hypothesis (Loewenstein, Weber, Hsee, & Welch, 2001) assumes a dual-process model according to which people assess risks cognitively and emotionally. In general, the emotional appraisal is considered as stronger than the cognitive appraisal. The affect heuristic describes how affective reactions influence risk perception. According to this heuristic, people consult their "affect pool" as a cue about the judgment of a risk (Finucane, Alhakami, Slovic, & Johnson, 2000; Pachur, Hertwig, & Steinmann, 2012). For instance, when comparing two risks, a person might infer that the risk that evokes a stronger emotional reaction (in terms of dread) is more prevalent.

Affective reactions also account for how people simultaneously perceive benefits and risks. Benefits and risks of technologies or medical treatments are usually positively correlated in our environment: A greater benefit goes along with a greater risk. Yet people's perceptions of benefits and risks are usually negatively correlated. Technologies with high benefits are perceived as less risky, and high-risk technologies are perceived as less beneficial. Alhakami and Slovic (1994) explained this pattern with participants' affective evaluation of technologies. Favorable affective evaluations result in high-benefit and low-risk perceptions, whereas unfavorable affective evaluations result in the opposite pattern (see also Slovic, Finucane, Peters, & MacGregor, 2002).

Availability Heuristic

Another strategy is to judge risks via the availability heuristic, that is, to judge "the frequency of a class or the probability of an event by the ease with which instances or occurrences can be brought to mind" (Tversky & Kahneman, 1974, p. 1127). Whether and when this heuristic leads to accurate risk perception depends on the structure of the environment. Assuming that more frequent events are easier to recall, risk perception should be quite accurate. However, factors such as memorability, imaginability, or disproportional media coverage of an event can bias risk perception. In their seminal work, Lichtenstein, Slovic, Fischhoff, Layman, and Combs (1978) used two different methods to elicit participants' frequency judgments. In one method, they presented participants pairs of causes of death and asked them first to state which causes a higher number of deaths and second to estimate the ratio of their frequencies. In another method, participants had to estimate the frequency of an event and prior to estimation received either a high anchor (motor vehicle accidents cause 50,000 deaths per year) or a low anchor (electrocution causes 1,000 deaths per year). Participants' absolute risk judgments were influenced by the anchor. When the high anchor was provided, risk estimates were about two to five times higher than when the low anchor was provided. When it comes to relative judgments, participants performed better, and more frequent risks were generally identified as more likely when compared with a less frequent risk. However, two biases were obtained. First, participants overestimated low frequencies and underestimated high frequencies (primary bias). Second, participants assigned different ratios to different pairs of causes of death even when the ratio was the same (secondary bias). The availability heuristic was proposed to explain these biases: People base their estimates on recalled instances. If the recall of available instances in the mind is proportional to the actual frequency of the event, then people correctly assess the risk. However, when the recall of instances is not proportional to the actual frequency, then people may misjudge risks that could explain the primary bias.

Two major criticisms with respect to the availability heuristic have been raised (e.g., Hertwig, Pachur, & Kurzenhäuser, 2005). First, the heuristic has often been used as a post hoc explanation rather than to predict risk perception patterns. Second, the original definition does not distinguish between ease of recall and actual number of recalled instances. Hertwig and colleagues (2005) addressed the two criticisms and compared several models that specified these processes precisely. Their results were similar to those from Lichtenstein et al. (1978). Moreover, the authors compared two different versions of the availability heuristic: First, availability-by-recall operationalized by the number of instances one recalls from one's social circle (e.g., family members, friends, colleagues). Second, fluency operationalized by the anticipated ease of recall with which instances can be brought to mind. Fluency was modeled in two ways: (1) the speed with which instances come to mind and (2) the occurrence of events in the media. Availability-by-recall better predicted people's choice than fluency, and it suggests that, at least in this context, availability may be primarily defined by the number of recalled instances. However, it should be noted that there are situations in which availability-by-recall is not applicable, namely, when a risky event has not (yet) occurred in one's social circle. Yet the social environment seems to play an important role in the evaluation of risks. Furthermore, the author also tested other possible mechanisms that could explain the data. For instance, regressed frequency assumes that people monitor the occurrence of risks but tend to overestimate small and underestimate low risks as a consequence of a regression-to-the-mean effect. In a later study, Pachur et al. (2012) also compared whether availability-by-recall or the affect heuristic better described people's risk judgments and found that availability-by-recall was a stronger predictor than affect for frequency estimates, although the affect heuristic described participants' value of a statistical life and perceived risk similarly well.

Optimism Bias

When asked about their risk in comparison to the average risk, people often show unrealistic optimism: They believe themselves to be better off and less likely to experience negative life events (or more likely to experience positive events) than others (Weinstein, 1987). Optimism bias, also termed the *above-average effect and comparative optimism*, serves as an explanation of why people often do not take precautions and instead simply discount their personal risk ("It won't happen to me"). For example, when Weinstein (1987) presented participants with 32 different life hazards, participants on average rated their chance of experiencing the hazard to be below average on 25 of them. However, it is important to note that optimism bias is primarily defined on a group level as it compares average ratings with average population risks. This is due to the fact that one has usually no knowledge about the actual risk of an individual.

Different explanations for optimism bias have been proposed. Shepperd, Carroll, Grace, and Terry (2002) identified four broad categories: (1) the desired end state of comparative judgments (e.g., self-enhancement), (2) cognitive mechanisms (e.g., representativeness heuristic), (3) information about self versus target (e.g., person–positivity bias; discounting background information), and (4) underlying affect (e.g., mood congruency; for an overview, see also Chambers & Windschitl, 2004).

But is thinking to be better than average always a bias? Studies found that the majority of people believe that they drive more safely than the average (Johansson & Rumar, 1968; Svenson, 1981)—which is considered a bias as it is simply not possible that the majority are better than average. However, a closer look at the distribution of car accidents shows that most drivers have few accidents, and few drivers have many accidents. In such a nonsymmetric distribution, the median and the mean are not identical (Gigerenzer, Fiedler, & Olsson, 2012). Hence, the majority of drivers (i.e., more than 50%) have actually less accidents than the average. For instance, of 7,800 drivers in the United States, 80% had fewer accidents than average; and of 440 German drivers, 57% had fewer accidents than average. Hence, in this case, the better-than-average effect is no bias.

Representation of Risk: Fuzzy-Trace Theory

The way we perceive risks strongly depends on how we mentally represent them. Fuzzy-trace theory addresses this issue and distinguishes between two kinds of representations: verbatim and gist (Reyna, 2008; Reyna & Brainerd, 1995). Verbatim representations encode the stimulus objectively—that is, as it actually happened. For example, imagine that mammography screening reduces breast cancer mortality for women aged

50 and older by 1 in 1,000 (i.e., from 5 in 1,000 without screening to 4 in 1,000 with screening) (Gøtzsche & Nielsen, 2011). The verbatim representation would encode the exact wording and numerical information from the statement. In contrast, gist representations are more fuzzy and encode the information subjectively, that is, they interpret the information. For instance, a risk reduction of 1 in 1,000 could be translated into a "small" effect. Although individuals have different gist representations due to experience, knowledge, and emotional reactions, they do not differ in their verbatim representations. Moreover, in contrast to other dual-process approaches, fuzzy-trace theory states that the two representations are encoded, stored, and retrieved in parallel rather than sequentially.

Fuzzy-trace theory has been applied to a wide range of tasks in judgment and decision making and risk perception to explain framing effects, denominator neglect, and the role of emotions in the encoding of risk information (Reyna & Brainerd, 2011). Generally, findings suggest that people rely more heavily on gist than on verbatim representation. This tendency increases with age and expertise. The advantage of gist representations is that they are more stable and less prone to interference, whereas verbatim representations are more error prone and can be easily forgotten. Errors in gist representations can occur (because gist reflects understanding). So a woman might interpret reducing breast cancer with mammography as reducing cancer mortality. However, reliance on gist is generally associated with lower levels of unhealthy risk taking and more developmentally advanced decision making (e.g., Reyna et al., 2011).

Media and Risk Perception

The media are commonly perceived as an important mediator in the perception of risk (see also Part II, Section 4). If the media covered hazards proportional to their actual occurrence, the media would represent a good proxy for the actual frequency of such events. However, if media coverage is disproportional to the actual frequency of a hazard—for instance, if dramatic, low-probability events are covered more often—the media could contribute to people's tendency to misrepresent risks. In an early study, Combs and Slovic (1979) found that the frequency of newspaper reports about causes of death correlated more highly with laypeople's estimates than with the actual frequency. In contrast, Freudenburg, Coleman, Gonzales, and Helgeland (1996) systematically analyzed whether the media primarily exaggerated risks and found only little support: The objective severity of events (i.e., number of casualties) predicted media content. Hence, the frequency of reports in the media is not necessarily biased; just as the media's reaction to events is often quick and dramatic, so, too, is the rate at which such instances diminish in the media and get substituted by other news.

Does the frequency of reporting influence risk perception? In the above-mentioned study by Hertwig and colleagues (2005) on the availability heuristic, fluency—operationalized through the occurrence of instances in the media—did not predict participants' risk judgments of societal risks compared with, for instance, availability-by-recall. Although the media are one source providing information about risks and its occurrence in the environment, it is only one of many factors influencing risk perception, and effects of selective and short-term intensive media coverage may only be temporary (Sjöberg et al., 2000; Wahlberg & Sjöberg, 2000).

However, not only does the frequency of information in the media matter (i.e., *which* information is provided) but also the format of the information (i.e., *how* the information is provided). Media coverage is often biased as it presents incomplete and nontransparent information. For instance, newspaper and Internet reports about the human papillomavirus vaccine lacked fundamental statistical information about its benefits and harms (Bodemer, Müller, Okan, Garcia-Retamero, & Neumeyer-Gromen, 2012). Studies covering participants from nine European countries showed that a vast majority of people overestimates the benefits of cancer screening, or does not know (Gigerenzer, Mata, & Frank, 2009); those who acquired more information about it did not know better, but even tended to know less well. This suggests that many information channels, including the media, often fail to provide adequate information about health risks.

Moderators in Risk Perception

Besides the media, other factors moderate risk perception. We briefly summarize these below.

Age

Risk Perception in Adolescents

The prevalence of risks and its perceptions is also not constant, but changes across the life span. Whereas some risks are more prevalent in young age (e.g., sexually transmitted diseases, crimes, alcohol), others are more prevalent in older age (e.g., cardiovascular diseases, cancer). A widely held but unsupported belief is that adolescents engage in risky behavior because they feel invulnerable. In fact, the opposite may be true. Quadrel, Fischhoff, and Davis (1993) found that adolescents are less inclined to optimism bias compared with adults. In addition, adolescents provide higher risk estimates than adults for various natural hazards and behavior-linked outcomes (Millstein & Halpern-Felsher, 2002) and overestimate their risk of dying in the near future (Fischhoff, Bruine de Bruin, Parker, Millstein, & Halpern-Felsher, 2010). A second common belief is that adolescents are less rational—however it may be defined—than adults. Yet studies applying fuzzy-trace theory on risk perception obtained the opposite finding: Gist-based representation increased from childhood through adolescence to adulthood (Reyna & Farley, 2006). In other words, adolescents base their decisions more often on verbatim representations corresponding to the classic notion of “rational” and deliberate thinking.

Risk Perception in Older Adults

Only few studies systematically investigated how older adults perceive risks. Hermand, Mullet, and Rompteaux (1999) compared risk perception across different age groups and included older adults but found no support that older adults show higher risk perceptions than younger adults across 91 hazards (only a slightly higher perception of risks for surgery and radiation therapy). When it comes to the understanding of risks, older adults have difficulties in correctly interpreting health statistics compared with younger adults. Yet adequate communication formats such as graphical tools can overcome shortcomings (Galesic, Garica-Retamero, & Gigerenzer, 2009).

Expertise and Risk Perception

Laypeople’s and experts’ risk perceptions are often discussed in a dichotomous manner: Experts assess risk objectively, analytically, and wisely, whereas laypeople are more emotional and irrational in their risk perception (Slovic, 1999). However, this may be a very general assumption as it may only hold for some situations, but not all. Sjöberg (1998) proposed three areas in risk perception to illustrate a more fine-grained analysis of the commonalities and differences between laypeople and experts: (1) common, well-known risks (e.g., fatalities for common diseases), (2) technological risks (e.g., nuclear waste disposal), and (3) lifestyle and job environment risks (e.g., domestic radon, smoking, alcohol). In line with the psychometric paradigm, laypeople may show higher risk perception than experts for technology risks. However, the pattern might be reversed for lifestyle and job environment risks. Furthermore, the two groups may, on average, have very similar perceptions in the case of common and well-known risks, where both, laypeople and experts, assess the frequency relatively precisely.

Risk Perception and Values

How we perceive risks also depends on our personal and cultural values, as proposed by the cultural theory of risk (Douglas & Wildavsky, 1983). In one study, Kahan, Braman, Slovic, Gastil, and Cohen (2009) investigated laypeople's perception of the risk of nanotechnology. At the time of the study, the vast majority of participants had never heard of nanotechnology, and risk perception did not depend on cultural values initially. However, after they received balanced information about this technology, participants with different cultural values interpreted the information in different ways: Only a minority (23%) of those with an egalitarian–communitarian worldview (people who tend to take environmental risks seriously) now thought that the benefits of nanotechnology would outweigh the risks. In contrast, a large majority (86%) of those with a hierarchical–individualist worldview (people who tend to dismiss claims of environmental risk) now thought that the benefits of nanotechnology would outweigh the risks.

The White Male Effect

First observed by Flynn, Slovic, and Metz (1994), the white male effect states that white men fear and worry about risks less than women or minorities. Socioeconomic status and education were proposed as possible mechanisms underlying this effect; yet even when controlling for both, the white male effect occurs (Finucane, Slovic, Mertz, Flynn, & Satterfield, 2000). A possible explanation for the effect stems from its interaction with values, worldviews, and culture–identity protection (Kahan, Braman, Gastil, Slovic, & Metz, 2007). First, worldviews correlate with demographic variables. Second, culture/identity-protective cognition suggests that we act in a way to protect identity, that is, our worldviews, interests, and in-group. For instance, people who hold hierarchical and individualistic worldviews may consider guns as less dangerous (i.e., their perception of risk is lower), as they value guns as part of their social roles and individual virtues. This pattern was most dominant among people with hierarchical and individualistic worldviews, which in turn was most prominent in a subgroup of white males. Hence, the distribution of worldviews in line with culture–identity protection can explain why specific subgroups fear some risks more than others.

The Role of Numeracy in Risk Perception

Individuals differ in their ability to deal with numerical and statistical information, which in turn influences the perception of risks. For instance, people low in numeracy give higher estimates of actual risks and treatment effectiveness than people high in numeracy (Dillard, McCaul, Kelso, & Klein, 2006; Schwartz, Woloshin, Black, & Welch, 1997). Less numerate people are also more sensitive to the way risks are framed, that is, whether a risk is presented in a gain or loss frame, or in percentage or frequency format (Garcia-Retamero & Galesic, 2010; Peters et al., 2006). What actually underlies this effect and whether it is primarily due to less numerate people having difficulties adequately interpreting and using scales measuring risk perception remain open questions (Reyna, Nelson, Han, & Dieckmann, 2009).

Reflections for Theory and Research

With the rise of new technologies in our world, and new developments in cognitive psychology, models and theories have been developed and applied to the perception of risk. The social amplification of risk framework considers risk perception as a communication process within social and institutional contexts. Thereby, it suggests possible factors that influence how we perceive risks and how risk perception develops across different stations; yet it does not make predictions on a cognitive level. The psychometric paradigm focused on the identification of the psychological mechanisms that influence risk perception by highlighting two major factors: dread risk and novelty risk. However, the major level of analysis was on an aggregated level, again neglecting the actual underlying cognitive processes and individual differences. The risk-as-feelings hypothesis, affect heuristic, and availability, in contrast, aim at describing how individuals mentally perceive and judge risks and extends previous models by specifying and testing cognitive process models. Finally, fuzzy-trace theory adapts a dual-process approach to risk perception by distinguishing between verbatim and gist representations. Our understanding of risk perception further requires studying mediating factors such as age, gender, expertise, values, and worldviews.

Despite, or because of, the progress in recent decades, we would like to stress three major approaches for future research on risk perception. First, only limited effort has been spent on integrating different theories and models. Whereas most models have been postulated and tested in isolation, future research may address commonalities and differences and bring together different views to constitute an integrative framework to study risk perception. Thus, the focus should not only be on psychological theories, but it should also apply a multidisciplinary view on risk perception by including concepts from anthropology, sociology, communication research, and technology research. Second, and related, is the fact that most models are perceived as general models that describe and predict risk perception in different domains (i.e., for different risks). However, a more ecological approach might be useful: Just as humans have a wide range of tools in their adaptive toolbox to make decisions and judgments (Gigerenzer, Todd, & the ABC Research Group, 1999; Todd, Gigerenzer, & the ABC Research group, 2012), different tools may exist to assess risks in different situations. Depending on knowledge, time, expertise, and the risk to be judged, different cognitive strategies may be applied—the key question is when which is used. Third, most research on risk perception has focused on known risks, that is, situations in which the outcome is known and probabilities can be estimated. However, our distinction at the beginning of this chapter highlights that in many situations we do neither know the outcomes nor the probabilities. Up to now, we know only very little how people deal with such truly uncertain situations.

Recommendations for Practice

Based on the knowledge on how the mind perceives risks, we can design environments that facilitate and improve risk perception. For instance, a doctor may overestimate the prevalence of a disease, as she samples patients with the disease disproportionally to the population. After the 9/11 terrorist attacks, many people in the United States avoided flying and switched to their cars instead, resulting in an increase of highway fatalities (Gaissmaier & Gigerenzer, 2012; Gigerenzer, 2006). Understanding the underlying cognitive processes allows improving people's perceptions of risk and design information in such a way to reduce potential flaws in risk judgments.

One illustrative example of how psychological research can help understand and shape debates about public health risk issues was provided by Arkes and Gaissmaier (2012). They investigated the furor that followed when the U.S. Preventive Services Task Force recommended against using the prostate-specific antigen (PSA) test to screen for prostate cancer. Several factors documented by psychological research may have contributed to the public's condemnation of the report, for instance, that an anecdote or two can have a more powerful effect on decision making than a compendium of more reliable statistical data. The information given by the U.S. Preventive Services Task Force that "no trial has shown a decrease in overall mortality with the use of PSA-based screening through 11 years of followup" will not have the same impact as information, say, about the reader's mail carrier's older brother who had a positive PSA test, a biopsy, and a radical prostatectomy, and is now still alive. Psychological research has also developed more effective means to represent statistical information about clinical evidence, including tabular and graphical formats, so that it can be easily understood even by laypeople. Arkes and Gaissmaier suggest that augmenting statistics with these representations might help committees communicate more effectively with the public about health risk issues and with the U.S. Congress and could more generally be used to educate the public and elevate the level of civic discussion. More generally, providing "clean" information would be an important step toward a citizenship that deals with risks in an informed way (Gigerenzer & Gray, 2011).

The other important building block for helping the public understand risk is to teach the psychology and mathematics of risk. It is well documented that, for instance, low statistical numeracy in health distorts perceptions of risks, impedes access to treatments, and is associated with worse health outcomes (Reyna et al., 2009). As Meder and Gigerenzer (2014) put it, "Teaching statistical thinking should be an integral part of comprehensive education, to provide children and adults with the risk literacy needed to make better decisions in a changing and uncertain world" (p. 127). A curriculum that aims at improving people's risk literacy should ideally already start early and target children when they develop their skills and habits (Gigerenzer, 2014). An educated citizen knows which questions to ask and where to get good information and is more strongly protected against undue hopes and anxieties, including distorted perceptions of risk (Gigerenzer, Gaissmaier, Kurz-Milcke, Schwartz, & Woloshin, 2007).

Conclusions

In this chapter, we provided an overview of the psychological theories and models in risk perception research. Risk and risk perception are highly interdisciplinary constructs as they have different connotations in different domains. We reviewed major findings and challenged the individual theories and methods to illustrate their advantages and limitations. The following chapters illustrate the complexity and diversity of risk perception and highlight theoretical approaches to understand the interplay of the mind and the environment and its implications for risk communication.

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