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A Cognitive-Ecological Perspective on Risk Perception and Medical Decision Making

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What do humans fear? And what should they fear? These questions have occupied the behavioral, social, and decision sciences for many decades—and philosophers and theologians for much longer. And they still occupy us today in the study of human risk perception. The article by Fulawka et al.[1] in the current issue of *Medical Decision Making* contributes to our understanding of risk perception: building on decision by sampling theory,[2] the authors show that the intensity of fear associated with different diseases is related to their objective case fatality rates (CFRs), which represent their deadliness. Here, I would like to reflect on the findings from a cognitive-ecological perspective, which emphasizes that one can neither fully grasp the underlying mechanisms (here: of risk perception) nor their rationality without considering the interplay between the cognitive processes and the structure of the environment.[3–5]

The Importance of Public (Mis)perceptions of Risk

Public perception of risk is often at odds with scientific evidence.[6] People worry more about risks such as nuclear energy, genetically modified food, and nanotechnologies but much less about poor nutrition and a sedentary lifestyle, which experts deem more relevant.[7] On the societal level, accurate risk perceptions are important for deciding how to allocate limited resources and the acceptance of legislative policies regulating risks. On the individual level, accurate risk perceptions help people reduce harmful behaviors and prevent severe and frequent risks effectively. Policy makers, scientists, and health organizations therefore need to understand how people perceive risks and when and why their perceptions deviate from scientific consensus.

Widespread misperceptions of risk have costly consequences and contribute to underuse and overuse of medical care as well as to safety-decreasing behaviors. One example for underuse is vaccine hesitancy, which stems partly from misperceiving vaccines as more dangerous than the vaccine-preventable diseases, now considered among the 10 most important health problems worldwide by the World Health Organization (WHO).[8] Misperceptions of risk also contribute to overuse of medical care, for instance, when patients simultaneously overestimate their mortality risk and the benefits of aggressive treatments.[9] Finally, misperceptions of risk can fuel safety-decreasing behaviors, which occurred, for instance, when many Americans replaced (safer) flying by (more dangerous) driving after the 9/11 terrorist attacks, resulting in approximately 1,600 additional traffic fatalities in the subsequent year.[10,11] Because public (mis)perceptions of risk can have such grave consequences, it is crucial to gain a deeper understanding of the underlying mechanisms.

Mechanisms of Risk Perception

One of the earliest and most influential models is the psychometric paradigm,[7] which identified 2 factors that predict laypeople's risk perception: the first and stronger

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factor is dread risk, defined by perceived lack of control, dread, and catastrophic potential. The second identified factor is unknown or novel risk, defined as hazards that are unobservable, unknown, new, and delayed. Furthermore, 2 heuristics have been proposed as mechanisms underlying risk perception, by which people can infer relevant distal criteria (e.g., risk frequency) by proximal cues: the availability heuristic, which assumes that the proximal cue is the number or speed of instances that come to mind,[12] and the affect heuristic, which assumes that the proximal cue is how one feels about a risk.[13] Pachur et al.[14] formalized these heuristics to assess their accuracy and test them against each other. (Interested readers may also wish to refer to the earlier work of Hertwig et al.[15]) The formalization by Pachur et al.[14] of the availability heuristic as availability-by-recall—assuming risk judgments are based on recalling instances in one's social network—conformed best to people's responses and allowed accurate judgments of risk frequencies.

Fulawka et al.[1] similarly assume that people draw samples from their social environment to estimate how many people suffer and die from a disease. In line with this assumption, but without directly assessing recalled instances, the intensity of fear was predicted by objective CFRs based on WHO statistics, even after controlling for a range of other factors, and even though most people were not familiar with the WHO statistics. CFRs capture the deadliness of diseases as a ratio between mortality (i.e., how many people die of the disease) and morbidity (i.e., how many people get the disease). Interestingly, objective CFRs were a better predictor of fear than subjective CFRs based on individual estimates of mortality and morbidity. Affective responses such as fear thus reflect objective properties of the environment.

Taken together, there may actually be more sanity in the mechanisms underlying risk perception than often thought. Furthermore, it proves valuable to specify the underlying mechanisms of risk perception more precisely by basing them on theories of cognition, such as decision by sampling theory; it allows going beyond the short-sighted question of *whether* risk perception is accurate to understand *when* and *how* risk perception is accurate or inaccurate—a necessary step for a more complete picture of the rationality of human risk perception, which I will discuss next.

Reflections on the Rationality of Risk Perception

From a cognitive-ecological perspective, human rationality can only be understood by considering the interplay between cognitive processes and the structure of the environment.[3–5] This has important implications for evaluating the rationality of human risk perception, which is the outcome of 2 processes[3]: first, an environmental sampling process, in which people draw observations (such as diseased individuals in one's social network) that allow inferring a distal reality that cannot be directly observed (such as morbidity rate), and, second, a cognitive process that works with the input from the environmental sampling process. Biased judgments can therefore result from biased environmental samples, biased cognitive processes, or both.

Rethinking judgment biases from this perspective reveals that many biases that have traditionally been attributed to internal causes, such as biased cognition or motivated reasoning, could be fully accounted for by assuming unbiased cognition but biased environmental input.[16] Galesic et al.,[17,18] for instance, could simultaneously explain seemingly contradictory judgment biases, such as false consensus and false uniqueness, by the same cognitive processes based on biased samples from people's social circles. Similarly, even with unbiased cognition, risk perception will be biased if environmental samples are biased, which happens, for instance, when adverse events of medications are reported with a higher probability than their absence[19] or when the media coverage is biased toward specific causes of death.[20] (Note, however, that more recent evidence suggests a smaller impact of media coverage.[14,21])

Cognitive processes can be an additional source of bias if factors unrelated to risk frequency feed into risk perception, such as whether hazards are natural or human-made.[22] Furthermore, cognitive processes can take more or less adequate aspects of (biased or unbiased) environmental samples into account. Consider again fear reactions toward various diseases.[1] Should men, for instance, be more afraid of pancreatic or prostate cancer? Pancreatic cancer is rare but extremely deadly: per every 100,000 men and year, it is diagnosed in 14.6 men, and 12.6 die of it.[23] Prostate cancer is much more frequent and causes more fatalities overall but is much less deadly: per every 100,000 men and year, it is diagnosed in 109.5 men, and 19.2 die of it.[24] Which disease one should perceive as higher risk depends on the perspective: being diagnosed with pancreatic rather than prostate cancer should be much more frightening, because, given the diagnosis, all that matters is deadliness. When deciding, as policy makers or individuals, which disease to prioritize in prevention, however, one should rather invest in preventing prostate cancer. Fulawka et al.[1] predicted fear reactions by CFRs that reflect deadliness rather than by mortality rates that reflect the total risk for healthy individuals. Fulawka informed me that a model including mortality rates instead of CFRs was equally predictive

but had less desirable statistical properties (K. Fulawka, personal communication, July 23, 2019). Their study did not aim at teasing apart those different aspects, but it seems plausible that both deadliness and mortality rates influence affective fear reactions. This does not mean, however, that people cannot reasonably focus on different aspects of risk. The abovementioned study by Pachur et al.[14] found that availability-by-recall best described how people judged more objective risk frequencies, yet the relative impact of affect was larger for more subjective aspects of risk perception.

Conclusion

Asserting that human risk perception is sometimes severely biased and sometimes fairly accurate is correct but not helpful. Rather, we need a more precise understanding of how risk perception works. Fulawka et al.[1] illustrate the fruitfulness of grounding research of applied topics, such as risk perception, in theories of cognition such as decision by sampling.[2] Based on such studies, a cognitive-ecological perspective considering the interaction between cognitive processes and environmental structures enables us to better explain how misperceptions of risk emerge, which is important to counteract those misperceptions more effectively. This also entails deciding which aspects of risk perception to focus on for what purpose. To overcome a lack of emotion toward preventable risks (e.g., smoking), campaigns that target affective aspects may be most effective in changing behaviors.[25] To enable informed decisions based on individual preferences (e.g., about prostate cancer screening), in contrast, requires transparent risk communication that helps people understand probabilistic information.[26] In both cases, the better we understand how exactly cognitive processes interact with the physical and social environment, the more effective our interventions will be.

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