

Martina Raue · Eva Lerner
Bernhard Streicher *Editors*

Psychological Perspectives on Risk and Risk Analysis

Theory, Models, and Applications

Foreword by
Paul Slovic

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Foreword

I have been fortunate to study psychological aspects of risk since 1959. At that time, this was a topic of interest to only a handful of researchers, far from the mainstream of psychological inquiry. Risk and decision making then was the province of economists and mathematicians, building on a rich intellectual heritage going back centuries and based around formal models such as utility theory.

Only a few years earlier, in 1954, a psychologist named Ward Edwards, son of an economist, had written a brilliant review that eventually sparked a revolution. Titled “The Theory of Decision Making,” it sought to educate psychologists about economic theories and concepts, e.g., “utility,” and the potentially rich psychological issues underlying them. Edwards used his own research on probability and variance preferences among gambles as an example of how experimental psychology could be brought to bear on understanding human behavior in the face of risk. A few philosophers and mathematical psychologists joined the effort and a new field of study was born.

Now, more than half a century later, many hundreds of researchers have created a legacy of thousands of articles contributing to a complex, multifaceted, and fascinating portrait of risk perception, risk communication, and risk management. Even economists, long resistant to psychological approaches, have now joined the parade as champions of “behavioral economics.”

Readers of this book have, in one place, an up-to-date and authoritative overview of the important ideas and findings generated by these decades of empirical and theoretical research. Employing this knowledge won’t rid the world of risk, but it will make the world a safer place.

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Preface

Risk is not out there, waiting to be measured! Risk is subjective, danger is real.

—Paul Slovic

A firefighter can make a life-or-death decision under time pressure without thinking much about it. A child can cross a busy street without knowing facts about velocity or braking distances. Some people decide to go base jumping or free climbing, while others—or even the same people—get nightmares from the thought of having to fly in an airplane. Most people agree that measles pose a much greater risk than the vaccination against them, but a minority still refuses to have their children vaccinated. People fear terrorist attacks, but not heart attacks, despite the fact that more people die from heart attacks than terrorist attacks. Some companies grow and expand in the face of changing markets, new technologies, and emerging regulations, while their competitors fall into bankruptcy around them. These examples demonstrate that people, either for themselves or as members of an organization, are good at judging risk in certain situations, but fail in other situations. Different people judge risks differently than others, and some seem to take more risks than others. Psychology offers explanations for these observations, strategies to communicate risk effectively, and practical implications for industry and policy. This volume bundles many of these insights.

“Risk is subjective, danger is real,” but nevertheless, risk is often stated in numbers, mostly probabilities. How likely is it to die from an airplane crash? How likely are complications from a measles infection? How likely is a terrorist attack? How likely is it to die from a heart attack? How likely is it to win the lottery? How likely is heads over tails? Every decision situation that can be expressed in probabilities is a decision under risk. When I choose heads over tails, there is the “risk” of being wrong or losing when the coin flips to tails. The odds of the coin flip are clear; the chance of heads or tails is 50%. The chance of winning the lottery is about 1 in 175,000,000. But what are the chances of death or serious injury while base jumping? While experts can provide us with probabilities based on mathematical models or research data for some situations, high uncertainty still reigns in many others. How should I weigh the pros and cons of one medical treatment over another? How

do I make investment decisions without knowledge of future developments on the stock market? How threatening is climate change? Can I trust genetically modified food or additives? In the real world, we usually deal with situations of high uncertainty. But even when people are given numbers such as the likelihood of side effects for a medical treatment or of winning in a gambling situation, some uncertainty remains, and one's reasoning may not be "rational" in a mathematical sense.

Psychological aspects of risk and risk analysis were first systematically studied in the 1950s and 1960s, a time when economists treated people as rational decision-makers or "economic men" who make choices based on cost-benefit analyses. For decades, economic theories on human risk taking behavior were based on the assumption that human beings behave logically. However, most people do not engage in statistical analyses when they judge risks in their daily lives, instead relying on more "human tools." From the experienced firefighter who trusts his intuition based on years of learning to the child who is able to cross a busy street by using a simple rule of thumb, human beings have amazing abilities which guide them through the uncertainties of life. Consider the development of self-driving cars. This technology can make our streets safer and dispense with human cognitive limitations that are often the cause of accidents. At the same time, however, it is extremely challenging for the developers to integrate all possibilities inherent to the road environment and teach the car what to do in unusual situations. While a machine can easily learn how to judge the speed of approaching cars or to remain alert for bikes and pedestrians, it fails to make judgments in unclear situations that may ask for a small violation of traffic rules (e.g., in construction zones). In situations of uncertainty, humans have developed adaptive strategies that are sometimes better than machine-based algorithms—but may in other instances lead them astray.

When investigating human risk judgments, it makes a difference whether one looks at subjective risk perception or risk taking behavior. A base jumper might judge the risk of the activity at hand as high, but still jump; a person who is afraid of flying might judge the risk of flying as low, but not enter an airplane. Likewise, most smokers are well aware that smoking can cause cancer, but this awareness does not seem to prevent them from smoking. Psychological research has identified several factors that influence the perception and judgment of risks as well as risk taking behavior. This volume highlights how individual differences (Part I) and situational circumstances (Part II) influence risk perception and risk taking behavior. Behavioral models of human decision making under risk and the challenge of integrating different approaches and theories are discussed in Part III. This volume also gives an overview of practical implications for risk communication (Part IV) and in the areas of industry, policy, and research (Part V). This book aims at a broader audience beyond the field of scientific psychology; therefore, the chapters include many vivid examples to illustrate theoretical concepts. Each chapter also gives practical implications.

Individuals or groups of people differ in the way they perceive risk and in their willingness to take risk, which is the focus of Part I. The authors of Chap. 1, Marco Lauriola and Joshua Weller, review numerous studies on the relationship between risk taking and personality traits. This chapter gives a systematic overview on why

some people take more risks than others. The authors discuss different approaches of measuring risk taking, from self-reported behaviors to choice-based tasks. They also distinguish between risk-related personality traits such as sensation-seeking or impulsivity and general personality traits such as those included in the Big 5 personality inventories. They further include different domains such as recreational risks, social risks, ethical risks, health and safety risks, and gambling and financial risk taking. The chapter concludes with the argument that there is no single risk taking personality trait, but rather risk taking can be explained by the interplay of various traits and emotional states. The author of Chap. 2, Bruno Chauvin, reviews studies on the influence of sociodemographic characteristics, cultural orientation, and level of expertise on the judgment of risks. Based on a large body of research, he discusses the influence of sex and race, phenomena such as “the white male effect,” and the role of power in decision making. Further, Chauvin introduces studies on culture and risk perception, which has especially received attention in the literature within the *cultural cognition theory of risk*, and differences between experts and laypeople’s risk judgments. In Chap. 3, Vivianne Visschers and Michael Siegrist also look at the perceptions of experts versus laypeople, but focus specifically on differences between hazards as laid out in a *psychometric paradigm*. The authors discuss how potential hazards are sometimes perceived as more dangerous by the public than experts and how the public’s risk perception is often shaped by factors such as perceived benefit, trust, knowledge, affective associations, values, and fairness. Based on studies in various areas such as gene modification or climate change, they offer practical implications for risk management and communication.

In Part II, cognitive, emotional and social influences on human risk perception and risk taking are considered. In Chap. 4, Rebecca Helm and Valerie Reyna take a cognitive perspective on risk taking and also consider developmental and neurobiological research. The authors discuss *Prospect Theory*, dual process theories, *Fuzzy Trace Theory*, and *Construal Level Theory*. They point out how framing and mental representations of risk influence judgment and behavior and consider neural underpinnings of risk taking. Chapter 5, by Mary Kate Tompkins, Pär Bjälkebring, and Ellen Peters, gives an overview of current research on the role of affect and emotion in risk perception. The risk perception literature makes a primary distinction between risk as feelings and risk as analysis, and psychologists have pointed out the importance of feelings when judging risks. The authors thereby focus on the *affect heuristic* and the *appraisal-tendency framework*. Chapter 6, by Eric Eller and Dieter Frey, is centered around social influences on risk perception and risk behavior. Group influences, which have long been studied in social psychology, also affect decisions under risk, especially in professional contexts such as teamwork. The chapter points out how groups may hinder adequate risk identification, risk analysis, and decision making. The authors end the chapter with a set of recommendations to overcome these group barriers.

Part III especially focuses on observed human behavior, which is described in behavioral models of risk taking. In Chap. 7, Martina Raue and Sabine Scholl point to the challenges of considering many pieces of information or deciding under time pressure. As a result of these limitations, people simplify decision processes and use

rules of thumb or heuristics. The authors thereby focus on two approaches: the *heuristics and biases* program and the *fast and frugal heuristics*. In Chap. 8, Michael Birnbaum gives a systematic overview of behavioral models of risk taking, which are theories that describe human behavior in decisions that involve risk. While a normative model describes behavior as it ought to be in relation to an observed risk, a behavioral model describes behavior as it has been observed. In Chap. 9, Cvetomir Dimov and Julian Marewski discuss the challenges of theory integration. The authors argue that psychological researchers often aim at explaining the human mind without crossing the borders of their individual subdisciplines. They therefore call for more attention to theory integration. Readers may become aware of this issue when reading through the chapters of this volume that discuss sometimes competing approaches and theories. In this chapter, a method—*cognitive architectures*—is introduced to systematically integrate existing theories and empirical findings. The authors use two competing theoretical approaches of decision making under uncertainty—the heuristics and biases program and fast and frugal heuristics (introduced in Chap. 7)—to demonstrate how cognitive architectures work. In Chap. 10, Bernhard Streicher, Eric Eller, and Sonja Zimmermann point out limitations of existing approaches to handling risk and uncertainty. To overcome these limitations, they introduce a model of risk culture, which serves as an integrative framework for different theories of risk perception and behavior, as a reference point for holistic measurements, and as a starting point for evidence-based interventions.

Part IV is centered around risk communication and starts with Chap. 11, in which Ann Bostrom, Gisela Böhm, and Robert O'Connor discuss principles and challenges of communicating risks. They describe key components of risk information processing, including exposure and attention, understanding, evaluation, and behavioral response. The authors explore influences on each of these components and focus on the roles of uncertainty, mental models, choice architecture, and habits. In Chap. 12, Ulrich Hoffrage and Rocio Garcia-Retamero note that “risks are unavoidable, but poor risk communication and misunderstanding are really unnecessary.” The authors make several suggestions on how to improve risk communication in the health sector and focus on the interpretation of test results, the use of natural frequencies and visual aids, the difference between relative and absolute risk reduction, and the meaning of survival rates. In Chap. 13, Tamar Krishnamurti and Wändi Bruine de Bruin also focus on health risks and summarize four lessons learned for effective health risk communication on an organizational level. The four lessons include accessibility, appropriate delivery methods, pre-tests of communication practices, and the collaboration of interdisciplinary teams. All chapters in Part IV point to the importance of matching the risk communication strategy to the target audience’s goals, attributes, and mental model of the world they live in.

While all the chapters include a section on practical implications, the chapters in Part V are specifically centered around this aspect. In Chap. 14, Eva Lerner, Bernhard Streicher, and Martina Raue give an overview of recent research on measuring subjective risk estimates. It is of high practical importance for both researchers and practitioners to understand how risk perception can be measured and especially how it may vary depending on the measurement used. In Chap. 15,

insights on risk and uncertainty in the insurance industry are given by Rainer Sachs. This chapter is an overview of the professional work of risk managers. The author outlines how their methods and tools have developed historically from experience-based methods to mathematical models. He describes the limits of these models and challenges in the face of emerging risks and uncertainty. This volume closes with Chap. 16, in which Ortwin Renn summarizes implications of psychological aspects of risk perception for policy and government. He stresses that human risk perception may differ from statistical assessment of risks, but needs to be valued as an indicator for individual and societal concerns that require attention.

Theory integration is often challenging in scientific research (see Chap. 9 for a discussion), but the reader will notice that the chapters of this volume often overlap, demonstrating that various aspects, findings, and theories in the field of risk are integrated and acknowledged by the authors. The chapters also nicely complement one another. In that line, most chapters include cross-references within the book that can be used to gain a deeper understanding of concepts, models, and research findings.

It was a pleasure for us to work with outstanding authors who have shared their excitement about this book. All of them have been extremely motivated, dedicated, and open-minded. We cannot thank our contributors enough for making this book a very rewarding and successful project. We would also like to thank our wonderful editor at Springer, Morgan Ryan, who was exceptionally supportive during every step of this project.

Cambridge, MA, USA
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Martina Raue
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Martina Raue, Eva Lerner, and Bernhard Streicher jointly founded the *Risikolabor* (risk lab) at the Ludwig-Maximilian University Munich in 2011. While currently based at different institutions, they continue to collaborate on various research projects investigating human perception of risk and influences on risk taking behavior. In addition, they offer consulting and workshops on the topic. More about their work can be found at www.risikolabor.org.

Part I
Individual Differences in Risk Perception
and Risk Taking Behavior

Chapter 1

Personality and Risk: Beyond Daredevils— Risk Taking from a Temperament Perspective



Marco Lauriola and Joshua Weller

Abstract We reviewed studies relating risk taking to personality traits. This search long has been elusive due to the large number of definitions of risk and to the variety of personality traits associated with risk taking in different forms and domains. In order to reconcile inconsistent findings, we categorized risk taking measures into self-report behavior inventories, self-report trait-based scales, and choice-based tasks. Likewise, we made a distinction between specific risk-related traits (e.g., sensation seeking, impulsivity) and more general traits (e.g., the Big Five). Sensation seeking aspects like thrill and experience seeking were more strongly associated with recreational and social risks that trigger emotional arousal. Impulsivity was associated with ethical, health safety, gambling, and financial risk taking, due to disregard of future consequences and to lack of self-control. Among the Big Five, extraversion and openness to experience were associated with risk seeking; whereas conscientiousness and agreeableness had more established links with risk aversion. Neuroticism facets, like anxiety and worry, had negative relationships with risk seeking; other facets, like anger and depression, promoted risk seeking. We concluded that the notion of a unidimensional “risk taking” trait seems misleading. The interplay of many traits encompassed in an overarching temperament model best represented personality-risk relations. Positive emotionality traits promoted risky behaviors that confer an emotionally rewarding experience to the person. Negative emotionality traits lead to heightened perceptions of danger, primarily motivating the avoidance of risk. The last disinhibition affected risk taking as a result of differences in self-control control acting upon momentary feelings and in self-interest. Potential applications for practitioners are also discussed.

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For decades, the construct of risk taking has captured the attention of researchers from a multitude of disciplines, including clinicians, psychologists, and economists. Understanding *who* is more likely to take a risk has clear implications for one's financial, social, and personal well-being, as well as society in general. For instance, conceptualizing how individuals who engage in risky behaviors arrive at decisions can help to pinpoint identifying the underlying mechanisms that mediate maladaptive decision making processes. Additionally, identifying who is more likely to take a risk can improve risk communication efforts by means of tailored messages highlighting goals and values that are important to them.

However, the notion of a "risk taker" appears to be more complex than a singular category that can apply to behaviors spanning across a variety of different contexts. In fact, there has been some disagreement reflecting the degree to which risk taking tendencies are dispositional in nature. For those who indeed consider it to be dispositional, scholars have been divided about whether risk taking is better conceptualized as a unitary trait or as a domain-specific phenomenon. On the one hand, traits like sensation seeking and impulsivity were long thought to represent the personality basis of risk taking across different types of behaviors and situations (e.g., Enticott & Ogloff, 2006; Zuckerman & Kuhlman, 2000). On the other hand, supporters of a domain-specific approach suggest that risk behaviors may be qualitatively different from one another (e.g., Anderson & Mellor, 2009; Hanoch, Johnson, & Wilke, 2006; Soane & Chmiel, 2005; Weber, Blais, & Betz, 2002). Subsequently, different personality variables may uniquely account for variance across specific risk domains. For instance, Weller and Tikir (2011) found that dispositional honesty/humility predicted ethical and health risk taking, but not social or recreational risk taking. From this lens, a domain-specificity account of risk neither precludes the possibility that broader dispositional factors are associated with specific risk domains, nor does it necessarily rule out that stable overarching preferences for risk taking exist. Domain-specific risk taking studies often yield positive intercorrelations among risk propensity in different domains, as well as significant correlations between risk propensity and personality (e.g., Dohmen et al., 2011; Highhouse, Nye, Zhang, & Rada, 2016; Nicholson, Soane, Fenton-O'Creevy, & Willman, 2005; Weber et al., 2002; Weller, Ceschi, & Randolph, 2015a; Weller & Tikir, 2011). Additionally, test-retest correlations for risk taking demonstrate considerable temporal stability, up to 2 years (e.g., Chuang & Schechter, 2015, Table 1). These findings suggest that not only do stable individual differences in risk behaviors exist but also that broader personality traits may be associated with these behaviors.

Acknowledging that risk behaviors may be both domain-specific and multiply-determined, the current chapter proposes that individual differences in risk propensity can be best understood within the context of a broader, hierarchical personality framework, with each broad personality trait influencing some aspect of risk taking. Based on its theoretical ties to emotional and cognitive control processes, we organize our discussion around a "Big Three," or temperament-based, framework (e.g., Clark & Watson, 2008; Tellegen & Waller, 2008). Adult temperament models stress that the broadest dimensions, extraversion/positive emotionality (extraversion), neuroticism/negative emotionality (neuroticism), and disinhibition vs. constraint

(disinhibition), are affect-relevant traits. Because of this theoretical link, temperament models converge with advances in the behavioral decision literature that highlights the interplay between affective and cognitive processes, in the appraisal of risk and decision making in general (e.g., Loewenstein, Weber, Hsee, & Welch, 2001; Rusting, 2001; Slovic & Peters, 2006; Weber & Johnson, 2009).

The aims of this chapter are threefold. First, we address the issue of differences in conceptual definitions of risk taking and their corresponding operational definitions across disciplines, we believe, have hindered reaching common ground in this area (cf. Fox & Tannenbaum, 2011). Second, we briefly review the literature on traits that has demonstrated a link between personality and risk taking. Specifically, we examine the constructs of sensation seeking and impulsivity, as well as broad, higher-order trait dimensions (i.e., Big Five). Finally, we propose that these findings might be partly reconciled by framing the reviewed studies in terms of a Big Three model, linking personality traits to risk behaviors.

Definitions of Risk and Construct Validity of Risk-Related Traits

Like many constructs, the risk taking literature is no stranger to numerous theoretical and, therefore, operational definitions. Many different measures may exist, but it is unclear whether they assess the same construct. At best, research would yield moderate to strong correlations across different assessments; at worst, there would be no convergence across the different paradigms, suggesting that these variables may all assess different processes and perhaps constructs.

Choice-Based Experimental Tasks

One straightforward definition of risk taking, from an economic and financial perspective, is *the tendency to choose an option that has a greater outcome variance than another option*. From this perspective, a risky choice may not necessarily be associated with a negative outcome or a problem behavior. One of the first methods to quantify risk taking involved using *one-shot, hypothetical gambles*, eliciting a choice between a small number of options – usually between an uncertain, or risky, option (50% chance to win \$10, otherwise win \$0) and a certain option (100% chance to win \$5 for sure). Proponents of this method assert that it provides an analogue for how individuals use and integrate specific contextual information about a risky decision (e.g., the magnitude of the outcome and the probability that the outcome will be realized). These studies have been instrumental in demonstrating a gap between how people actually approach risky choices (e.g., prospect theory) and how a normatively rational actor would approach them (cf., Goldstein & Weber, 1995; Lopes, 1995, see also Birnbaum, Chap. 8).

Hypothetical gambles still are common in behavioral economics, based on the assumption that financial risk taking, and risk taking in general, can be modeled almost exclusively as maximizing the expectation of some individual utility function that maps on a cardinal scale the subjective value of each available choice option (cf., Friedman, Isaac, James, & Sunder, 2014; Takemura, 2014). Unfortunately, however, expected utility assessments of risk attitude have demonstrated limited predictive validity outside the laboratory or field context in which they were elicited (Anderson & Mellor, 2009; Dohmen et al., 2011; Friedman et al., 2014; Schonberg, Fox, & Poldrack, 2011; Weber et al., 2002). Moreover, the average risk taking pattern elicited by hypothetical gambles for which outcomes and probabilities are clearly stated before making a decision (i.e., a description-based decision) can differ from the pattern resulting from situations for which outcomes and probabilities are learned by experience (e.g., offering the decision makers a probability sampling or providing them with a feedback on their choices; Barron & Erev, 2003; Hertwig, Barron, Weber, & Erev, 2004; Hertwig & Erev, 2009; Schonberg et al., 2011). This knowledge has motivated researchers to develop behavioral paradigms that more adequately capture the psychological experience of risk. New paradigms have become increasingly popular, especially within the clinical neuropsychological literature (Schonberg et al., 2011; Weber & Johnson, 2009). Though not an exhaustive list, representative examples include the *Iowa Gambling Task* (IGT; Bechara, Damasio, Damasio, & Anderson, 1994), the *Balloon Analogue Risk Task* (BART; Lejuez et al., 2002), and the *Columbia Card Task* (CCT; Figner, Mackinlay, Wilkening, & Weber, 2009).

Tasks like IGT, BART, and CCT involve making repeated decisions in the face of uncertainty and directly experiencing the consequences of their choices. For instance, participants taking the IGT are asked to draw cards from four available decks differing in payoff size and structure. Two risk disadvantageous decks confer higher rewards on most trials but also very big losses on some trials, with a negative long-term expected value. The other two decks are risk advantageous, conferring lower rewards on most trials but only occasional small losses, with a positive long-term expected value. In order to perform well on this task, the participants must learn which decks are more advantageous, indeed drawing more cards for them than from disadvantageous decks. Another prominent task used to assess risk taking tendencies is BART. On this task participants are asked to inflate a virtual balloon displayed on a computer screen by pressing a pump button. Each click inflates the balloon and transfers \$0.05 to a temporary account. Participants are informed that the balloon can explode after each pump, erasing the money earned on the trial. However, if they stop pumping, they earn all of the points accrued for that balloon. As each pump is a gamble, which confers an additional reward but also involves increased risk (i.e., the chance of the balloon popping becomes greater), participants must learn about the stochastic structure of the task in order to perform well. The last risk task that we briefly review is the CCT. On this task participants take repeated trials in which they are presented with 32 cards presented face down and they are instructed to sequentially turn over them. Like BART pumps, every choice is rewarded, unless one turns a loss card. Different from IGT and BART, the CCT

offers to the decision precise information about the magnitude of gains, losses, and the associated probabilities. Indeed, the effect of learning is more limited for this task, and this perhaps makes the CCT a more refined and decomposable measure of risk taking tendencies than IGT and BART.

Although such paradigms differ in the types of decisions that are made, they collectively represent a major step toward developing a body of literature that appreciates the nuanced processes that may operate in guiding decision making across different risk contexts. Inspired by the pioneering work using the IGT to explicate decision making deficits in patients with neurological damage to the prefrontal cortex and amygdala, researchers have demonstrated the promise of showing differences between individuals with clinical diagnoses (e.g., substance use disorder) and healthy comparisons, as well as age-related differences in decision making (e.g., Bornovalova, Daughters, Hernandez, Richards, & Lejuez, 2005; Brevers, Bechara, Cleeremans, & Noël, 2013; Coffey, Schumacher, Baschnagel, Hawk, & Holloman, 2011; Kräplin et al., 2014). Specifically, these tasks also have led to insights into the neural correlates of risk behavior and how the development of these systems may impact risk taking tendencies over the lifespan (e.g., Bechara, Damasio, Damasio, & Lee, 1999; Gladwin, Figner, Crone, & Wiers, 2011; Paulsen, Carter, Platt, Huettel, & Brannon, 2011).

Self-Report Behavior Approaches

In contrast to a financial-based definition of risk taking based on variance, self-report methods define risk taking largely as *problem behaviors* that have the potential for negative consequences for the person (e.g., externalizing, addiction, gambling, unhealthy habits, etc.). One method involves directly asking individuals about their present or past risk behaviors, perceptions of risks, or the likelihood that one would engage in a behavior in the future. Some researchers have used a single survey question, asking about risk taking globally (e.g., “Are you generally a person who is fully prepared to take risks, or do you try to avoid taking risks?”; Dohmen et al., 2011), or have included global assessments across risk taking domains, such as recreation or health (e.g., “Please could you tell us if any of the following risks have ever applied to you, now or in your adult past?”; Dohmen et al., 2011; Nicholson et al., 2005). More refined measures have expanded on the behavioral self-report approach, including multi-item scales that are designed to provide more precision in the measurement of domain-specific risk taking. For instance, the *domain-specific risk taking* (DOSPRT; Blais & Weber, 2006; Weber et al., 2002,) provides a multidimensional measure across six broad risk domains: social (e.g., asking an employer for a raise), recreation (e.g., skydiving), investment (e.g., investing in a speculative stock), gambling (e.g., betting a portion of income on a sporting event), health/safety (e.g., drinking too much alcohol at a party), and ethics (e.g., cheating on a tax return). Another domain-specific inventory, the *passive risk taking scale* (PRT; Keinan & Bereby-Meyer, 2012), assesses

one's acceptance of risk due to inaction or omission of control across three domains: resource inaction (e.g., checking the credit card statements monthly), medical (e.g., flu vaccinations), and ethical domains (e.g., not say anything when receiving too much change at the store). Although these self-report measures tend to better predict outcomes than do one-shot experimental gambles, some skepticism remains on whether this difference reflects common method variance and redundancy between scale and outcomes in survey research (e.g., Anderson & Mellor, 2009; Charness, Gneezy, & Imas, 2013; Lönnqvist, Verkasalo, Walkowitz, & Wichardt, 2015; Nicholson et al., 2005).

Self-Report Trait-Based Approaches

Personality researchers interested in better understanding individual differences in risk taking have developed constructs, and corresponding scales, that are believed to represent the affective, cognitive, and behavioral indicators that predispose one to engage in risk behaviors. These indicators often include elements of preferences toward uncertainty, thrill and excitement seeking, harm avoidance, impulsiveness, and even the engagement in specific risk behaviors. For example, risk taking scales from the *Jackson Personality Inventory* (JPI; Jackson, 1994) and the *Personality Inventory for DSM-5* (PID-5; Krueger, Derringer, Markon, Watson, & Skodol, 2012) provide a total score that assumes variation on a single underlying factor. In contrast, scales like the *Stimulating-Instrumental Risk Inventory* (SIRI; Zaleskiewicz, 2001) or the *RT-18* (de Haan et al., 2011) are based on personality items akin to existing sensation seeking and impulsivity measures and consider risk taking tendencies as a multidimensional phenomenon.

It should be noted that personality-like items are sometimes included in risk taking inventories, and risk-related trait scales elicit endorsements of engaging in specific risk behaviors (e.g., "I have tried marijuana, or would like to"; "I would like to go scuba diving"; Zuckerman, Eysenck, & Eysenck, 1978), or conversely, some items ask whether a person likes to take risks but does not clearly define what a risk is. Nonetheless, no current broad-based personality model considers risk taking as a broad, orthogonal dimension, per se. Rather, several lower-order traits presumably related to risk taking appear in larger-scale personality inventories, like the *NEO-PI-R* (i.e., excitement seeking, impulsiveness, anxiety, anger, openness to actions; Costa & McCrae, 2008), the *Multidimensional Personality Questionnaire* (i.e., harm avoidance; Tellegen & Waller, 2008), the *Temperament and Character Inventory* (i.e., exploratory excitability, impulsiveness, harm avoidance; Cloninger, Przybeck, Svakic, & Wetzel, 1994), and the *Hogan Personality Inventory* (i.e., thrill seeking, experience seeking, impulse control; Hogan & Hogan, 1995). Additionally, items related to sensation seeking, impulsiveness, and risk taking also appear in the extraversion scale on the *Eysenck Personality Inventory* (Eysenck, Eysenck, & Barrett, 1985). Other personality inventories like the *HEXACO-PI* (Lee & Ashton, 2004) also include facets, such as unconventionality, social boldness, prudence, or

anxiety, along with the higher-order honesty-humility dimension, which may also contribute to risk taking, especially in the social, ethical, and health risk taking domains (e.g., Weller & Tikir, 2011).

Risk-related traits like impulsivity or sensation seeking have been long and extensively studied as predictors of a variety of real-world problem behaviors, such as reckless driving, health-risking sexual behaviors, gambling, alcoholism, and unethical behaviors (e.g., Chambers & Potenza, 2003; DeAndrea, Carpenter, Shulman, & Levine, 2009; Dahlen, Martin, Ragan, & Kuhlman, 2005; De Wit, 2009; Gullone & Moore, 2000; Hittner & Swickert, 2006; Hoyle, Fejfar, & Miller, 2000; Nelson, Lust, Story, & Ehlinger, 2008). Likewise, the degree to which different traits are associated with risk taking as a function of domains has recently been addressed using the DOSPERT or other multidimensional domain-specific measures (e.g., Gullone & Moore, 2000; Romero, Villar, Gómez-Fraguela, & López-Romero, 2012; Soane, Dewberry, & Narendran, 2010; Weller & Tikir, 2011; Zaleskiewicz, 2001).

Personality and Risk Taking

Because economists and psychologists from different subdisciplines have defined and measured risk in varied ways, mixed findings have arisen from using the same label (i.e., risk) for entirely different variables assessed in empirical studies (i.e., behavioral decision paradigms, behavioral self-report, or trait-based approaches). However, emerging from this lack of consensus is an increasing awareness that a unidimensional risk taking trait may not adequately explain individual differences in risk taking. As we will demonstrate in the following sections, research has strongly provided evidence that suggests that personality traits are correlated with specific types of risks. Moreover, these findings provide the foundation for considering risk taking within the context of a broader personality framework.

In this section, we briefly review some of the most commonly used personality indicators of risk behaviors. Specifically, we focus on two constructs, sensation seeking and impulsivity, as well as broader personality dimensions. Both sensation seeking and impulsivity are often deemed the traits that best represent a generalized latent disposition capable to motivate risk taking across domains and situations (e.g., Enticott & O'Gloff, 2006; Zuckerman & Kuhlman, 2000). Though often treated as unidimensional constructs, the multidimensional nature of these constructs can help to better place dispositional risk taking tendencies within the context of a temperament model of personality. For instance, facets of both sensation seeking and impulsivity are similar to other narrow traits in commonly used personality inventories and belong to broader and relatively orthogonal personality dimensions (Anusic, Schimmack, Pinkus, & Lockwood, 2009; Markon, Krueger, & Watson, 2005; Sharma, Markon, & Clark, 2014).

A temperament approach offers researchers several advantages. First, research has increasingly recognized that self-reports in temperament reflect underlying neu-

robiological mechanisms that are responsible for an individual's experience of positive and negative affect (e.g., Derringer et al., 2010; DeYoung, 2010; Munafo, Clark, & Flint, 2005; Reuter, Schmitz, Corr, & Hennig, 2007). Second, temperament is proposed to have a developmental history. Research has suggested that childhood temperament is linked to individual differences in temperament as an adult (e.g., Rothbart & Ahadi, 1994). Last, self-reported adult temperament has been found to be stable over time (Bazana, Stelmack, & Stelmack, 2004, for a meta-analysis of the stability of temperament traits). Thus, the temperament dimensions can be said to be enduring, stable dispositions, a feature that matches nicely with the search for stable risk preferences (cf. Fox & Tannenbaum, 2011).

Sensation Seeking and Risk Taking

Personality psychologists' interest in risk taking dispositions has grown due to the seminal work of Zuckerman and colleagues, who defined the sensation seeking trait as individual differences "in the seeking of varied, novel, complex, and intense sensations and experiences, and the willingness to take physical, social, legal, and financial risks for the sake of such experience" (Zuckerman, 1994, p. 27). From this perspective, risk taking is not a primary trait characteristic, but rather a reflection of seeking situations that satisfy one's need for arousal, excitement, novelty, and change, which often, but not necessarily, involve elements of risk.

Versions of the *Sensation Seeking Scale* (currently SSS-V is the most popular; Zuckerman et al., 1978) have been extensively used in personality-risk research (see Roberti, 2004 for a review). The SSS-V not only provides a global score that characterizes relative levels of overall sensation seeking but also includes four subscales: thrill and adventure seeking (e.g., involvement in risky sports), disinhibition (e.g., involvement in wild parties or uncontrolled situations), experience seeking (e.g., involvement in novel, strange, or unusual activities), and boredom susceptibility (e.g., constant need for arousal).

Before reviewing specific facets of sensation seeking, it is worth noting that people scoring high on the SSS-V total score typically approach risky situations with more self-confidence and good feelings compared to people who report lower scores on these scales (Horvath & Zuckerman, 1993; Zuckerman, 1994). Thus, beyond the popular view that sensation seekers are involved in risk taking for the mere sake of stimulating experiences, the literature also suggests that they place greater hedonic value on exciting activities. Consistent with an "affect heuristic" account, those who have good feelings toward a hazard or activity situation tend to perceive it as safer and expect greater benefits from it, thus increasing the likelihood of engaging in risk taking (e.g., Finucane, Alhakami, Slovic, & Johnson, 2000; Hanoch et al., 2006; Slovic, Finucane, Peters, & MacGregor, 2004; Weber et al., 2002). According to Zuckerman (2007), sensation seekers are likely to take risks across different domains (e.g., physical, social, legal, and financial risks). In one study, Zuckerman and Kuhlman (2000) tested the generality of sensation seeking-risk relations across six

types of behaviors (smoking, drinking, drugs, sex, driving, and gambling), each assessed by self-reported direct measures of risk taking. Higher overall sensation seeking scores were significantly correlated with all risky behaviors, except gambling and risky driving. In terms of construct validity, the study showed that a common personality factor linked sensation seeking tendencies to different types of risk. Roberti (2004) carried out a comprehensive review of the risky behaviors for which sensation seekers typically engage. Effect sizes tended to be medium to large for overall sensation seeking scores with substance use, gambling, reckless driving, and risky sexual experiences (e.g., multiple partners, unprotected sex, younger age for the first sexual intercourse, etc.), though were only considered medium in size for involvement in risky sports (e.g., extreme sports).

Because the need for arousal and stimulating experiences is a linchpin of the construct, risky choices that are more emotionally engaging are believed to demonstrate stronger correlations with sensation seeking. Supporting this assertion, Zaleskiewicz (2001) found that sensation seeking predicted self-reported “stimulating” risk behaviors (i.e., motivated by the need for arousal, e.g., skydiving, bungee jumping, or scuba diving), but “instrumental” risk behaviors (i.e., risks needed to reach some important future goal, e.g., business or financial decisions) were less strongly associated with sensation seeking. Similarly, decisions from description (e.g., hypothetical one-shot gambles, no experience of consequences) might lack the necessary element of arousal that rewards the decision maker and, thus, lower observed correlations between risk taking and sensation seeking (Zuckerman, 2007). However, as the activity or task becomes more of a decision from experience (e.g., BART, the affective or “hot” version of the CCT), sensation seeking would be predicted to demonstrate stronger correlations with behavior, corresponding with increases in autonomic arousal (Schonberg et al., 2011). Consistent with this view, Figner et al. (2009) found that the need for arousal scores, a construct closely related to sensation seeking, predicted risky choices on the affectively laden, experiential version of the CCT, but not on the more deliberative, non-feedback version of the task. In keeping with the view that sensation seeking tendencies are more related to risk taking on behavioral risk tasks that provide immediate feedback and trigger emotional arousal, de Haan et al. (2011) found that the risk taking subscale of the RT-18, which included items ostensibly related to sensation seeking, was more strongly associated with risk taking on the *Cambridge Gambling Task* (CGT, Rogers et al., 1999), an experienced-based risk taking task, than was the risk assessment subscale of the RT-18 (de Haan et al., 2011), which included more items ostensibly related to impulsiveness (vs. deliberation).

Sensation Seeking from a Temperament Perspective

Although these findings suggest that sensation seeking is broadly related to risk taking across a number of domains, only considering sensation seeking total scores may obfuscate specific contributions of unique facets specifically related to temperament. In this regard, Glicksohn and Abulafia (1998) reconsidered sensation

seeking as a trait that spans across the Eysenckian temperament dimensions of extraversion and psychoticism and, hence, proposed two major components. First, the non-impulsive, socialized mode of sensation seeking is most likely involved in seeking stimulating situations characterized by minimal or no risk; when risk is present, premeditation, intense training, or careful planning may be required (e.g., travel to exotic or unusual new places, perform in front of a big audience, sky or cycle downhill at high speed; see also Hansen & Breivik, 2001). For example, a mountaineer or a scuba diver might deliberately take risk facing variable conditions or hostile environments and yet adopt precautions to control the risk, such as checking weather forecasts or up-keeping air cylinders and equipments (Woodman, Barlow, Bandura, Hill, Kupciw, & MacGregor, 2013). Furthermore, sensation seeking is only one of the motives that drive people to engage in high-risk sport activities, and not all risky sports are equally appealing for sensation seekers (e.g., skydiving vs. mountaineering; Barlow, Woodman, & Hardy, 2013). In terms of SSS-V subscales, thrill and adventure seeking may be more strongly aligned with this component. In contrast, a second dimension, the impulsive, unsocialized mode, is most likely involved in engaging in stimulating experiences for which the risk of personal and social harm is high (e.g., gambling, bullying others, attending “wild” parties). Disinhibition and boredom susceptibility subscales may be especially strong markers of this component. Accordingly, Glicksohn and Abulafia (1998) suggest that the former component is more strongly associated with extraversion, whereas the latter component is more strongly tied to psychoticism, a construct similar to disinhibition in a Big Three temperament framework.

As anticipated, de Haan et al. (2011) developed a brief risk taking measure that included items tapping into sensation seeking tendencies from different personality inventories. The analysis yielded a first factor, labeled *risk taking*, characterized largely by items describing enjoyment or involvement in a variety of stimulating risky situations; whereas a second factor labeled *risk assessment* included items reflecting the tendency to deliberate over choices compared to acting impulsively. Furthermore, the two factors were moderately intercorrelated, and the group of people scoring higher on the risk taking subscale and lower on the risk assessment ones included more risk takers, such as recreational drug users, that not only sought for stimulating experiences but also, but less so, were less likely to approach decisions in a reasoned, deliberative manner. Likewise, Woodman et al. (2013) developed a *Risk Taking Inventory* for high-risk sport participants.

Given these insights, we can reconsider Zuckerman and Kuhlman's (2000) findings that overall sensation seeking did not correlate with risky driving and gambling. In fact, if only some facets of a multifaceted trait can predict a specific target variable, using the total trait score for prediction can be misleading because non-predictive facets might dilute the predictive relationship of other facets more closely tied to the target variable of interest. In keeping with this view, research has suggested that separate SSS domains may more or less strongly be associated with specific types of risk behavior, which may attenuate total score correlations with the criterion. For instance, Jonah (2001) found that the thrill and adventure seeking

subscale showed stronger correlations with risky driving than did the other subscales. Conversely, Fortune and Goodie (2010) found mean-level differences between pathological and non-pathological gamblers for the disinhibition and boredom susceptibility subscales, but not the experience seeking or thrill and adventure seeking subscales.

More broadly, we can consider these results within a temperament perspective. Specifically, thrill and adventure seeking involves seeking and positively appraising arousing and stimulating events, which may be more strongly associated with positive emotionality. By contrast, disinhibition and boredom susceptibility, relate to the impulsive, unsocialized mode, may be more strongly aligned with disinhibition (vs. constraint). As we will explain in a later section, this distinction may have important implications for understanding the personality antecedents of domain-specific risks.

Impulsivity and Risk Taking

Like sensation seeking, impulsivity is a trait that has been extensively associated with real-world risk taking (e.g., Chambers & Potenza, 2003; Dahlen et al., 2005; De Wit, 2009; Hoyle et al., 2000). Real-world risky behaviors often involve a choice between an immediate reward associated with a bad habit (e.g., taking drugs, gambling, or smoking) and a delayed greater reward that might be obtained by ending that habit (cf., Chapman, 2005; Critchfield & Kollins, 2001). Therefore, it has been hypothesized that impulsive individuals are inclined to engage in maladaptive risky behaviors to the extent that they value the immediate positive consequences of their actions (e.g., the exhilaration of gambling) to be larger than delayed advantages deriving from abstaining from those actions.

Impulsivity is a construct that has been conceptualized in a multitude of ways, including present time orientation, inability to delay gratification, reward sensitivity, impaired cognitive control, quick decision making, lack of premeditation and planning, and even behavioral disinhibition, sensation seeking, and risk taking (Bari & Robbins, 2013; Enticott & Ogloff, 2006). For purposes of the current chapter, we follow a recent definition offered by Moeller, Barratt, Dougherty, Schmitz, and Swann (2001), who argue that a description of impulsivity needs to incorporate an individual's tendency to demonstrate decreased sensitivity to less favorable behavioral consequences both in the short- and long-term and fast responses based on incomplete information processing. Moeller et al. (2001) also note that, based on these definitional components, impulsivity involves risks but suggest that impulsive risk taking may be distinguished from sensation seeking risks.

The impulsivity literature is voluminous, and a full review of methodologies span beyond the scope of the chapter. However, we describe several methods by which impulsivity is measured, both from self-report and behavioral perspectives, to highlight personality processes linking impulsivity with risk taking.

Self-Reported Impulsiveness

Several measures of impulsiveness have been developed but tend to include different dimensions. For instance, Dickman (1990) categorized impulsivity as dysfunctional or functional, depending on whether one's tendency to make quick decisions was associated with the choice of disadvantageous or advantageous options, respectively. Other measures are distinguished between different forms of impulsivity, including motor (e.g., acting on the spur of the moment), non-planning (e.g., doing things without thinking), and inattention (e.g., distractibility; Patton, Stanford, & Barratt, 1995). Likewise, Whiteside and Lynam (2001) made fine-grained distinctions among (lack of) premeditation (e.g., acting without deliberation), urgency (e.g., acting hastily under positive or negative mood states), (lack of) perseverance (e.g., easily being distracted), and sensation seeking. Collectively, impulsivity facets in self-report scales are related to risk taking with a small-medium effect size (i.e., $0.20 < r < 0.50$). However, research has also shown that specific facets account for unique portions of risk taking variance, thus potentially affecting risk taking through specific pathways or processes (e.g., Sharma, Kohl, Morgan, & Clark, 2013; Stanford et al., 2009).

Behavioral Paradigms

A variety of behavioral measures have been used to measure impulsivity, often focusing on either inter-temporal choice paradigms or testing attentional components of impulsivity. Inter-temporal choice, or delay discounting, tasks have been used to describe how people trade off between smaller sooner rewards and later larger ones (for a review of inter-temporal choice research and discount rate elicitation methods, see Green & Myerson, 2004). Conceptually, these tasks measure how much a reward loses subjective value based on the delay to the reward being received. For example, the *Monetary Choice Questionnaire* (MCQ; Kirby, Petry, & Bickel, 1999) includes 27 items, each requiring a choice between a smaller immediate monetary amount and a larger delayed one (e.g., "Would you prefer \$33 today or \$80 in 14 days?"; Kirby et al., 1999, p. 81). Individuals are said to be more impulsive the more quickly a reward loses its value as a function of its delay; that is, the higher their discount rate. Sometimes, they are even referred to as *impulsive decision makers*, a term that denotes the close link between impulsivity and decision making processes (cf., Green & Myerson, 2004). These preferences have been shown to have considerable temporal stability, in some cases up to many years (e.g., Kirby, 2009; Odum, 2011; Ohmura, Takahashi, Kitamura, & Wehr, 2006).

Converging evidence supports the claim that these impulsive decision makers show higher instances of engaging or persist in risky behaviors than those with lower discount rates. For instance, research has demonstrated greater levels of average discount rates between clinical samples of, for example, substance users and problem gamblers and healthy comparison groups (e.g., Alessi & Petry, 2003; Bornovalova et al., 2005; Coffey, Gudleski, Saladin, & Brady, 2003; MacKillop