The Relative State Model: Integrating Need-Based and Ability-Based Pathways to Risk-Taking

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Abstract

Who takes risks, and why? Does risk-taking in one context predict risk-taking in other contexts? We seek to address these questions by considering two non-independent pathways to risk: need-based and ability-based. The need-based pathway suggests that risk-taking is a product of competitive disadvantage consistent with risk-sensitivity theory. The ability-based pathway suggests that people engage in risk-taking when they possess abilities or traits that increase the probability of successful risk-taking, the expected value of the risky behavior itself, and/or have signaling value. We provide a conceptual model of decision-making under risk—the *relative state model*—that integrates both pathways and explicates how situational and embodied factors influence the estimated costs and benefits of risk-taking in different contexts. This model may help to reconcile long-standing disagreements and issues regarding the etiology of risk-taking, such as the domain-generality versus domain-specificity of risk or differential engagement in antisocial and non-antisocial risk-taking.

Keywords

risk, risk-sensitivity theory, embodied capital, signaling, evolutionary psychology, individual differences, domain-specificity, antisocial conduct

Introduction

Who takes risks, and to what extent does risk-taking in one context predict risk-taking in another? One line of evidence supports a common argument that risk-taking is domain-general, in that various risk-taking behaviors tend to co-occur among individuals across multiple contexts and are consistently associated with stable individual differences. An alternative line of evidence supports a different argument that risk-taking is domain-specific, in that individuals appear to make separate cost–benefit calculations for the utility of risk-taking in separate domains (i.e., different decision contexts). There are also two seemingly opposing models that purport to explain which individuals tend to take the most risks: One interprets risk-taking as the last resort of the desperate (risk-sensitivity theory); the other interprets risk-taking as an affordance of privilege (signaling ability).

In this article, we review existing frameworks and evidence for each of these positions. We provide a theoretical argument that these frameworks can all be reconciled by considering two broad, interrelated pathways to risk-taking: need-based and ability-based. We then provide a conceptual model—the *relative state model*—that integrates both need-based and ability-based pathways and provides novel predictions about decisions under risk relevant to multiple domains of social behavior. Finally, we discuss the implications of this model for resolving the debate over the domain-specificity versus domain-generality of risk-taking, and discuss implications of the model to understanding social behavior more generally.

Defining Risk

Researchers in the behavioral sciences, including economics, biology, and psychology, have largely converged on a definition of risk as payoff or outcome variance (e.g., Bernoulli, 1738; Daly & Wilson, 2001; Friedman & Savage, 1948; Mishra, 2014; Real & Caraco, 1986; Rubin & Paul, 1979; Winterhalder, Lu, & Tucker, 1999). For example, a gamble that offers a 25% chance at winning $1,000 is riskier than receiving $250 guaranteed, even though both options have the same expected value ($250). More generally, behaviors can be considered risky if they have higher associated outcome variance than other alternative behaviors.

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The definition of risk as outcome variance has the virtue of being broader and more inclusive of a variety of behaviors than other qualitative definitions of risk (e.g., risk as "self-defeating," "irrational," or "reckless" behavior; Leith & Baumeister, 1996; Pham, 2007; Sen, 1990). Risk as outcome variance also does not imply any value judgments. Describing risk-taking as "self-defeating" or "irrational" is pejorative and implies that risk-taking is necessarily maladaptive. Risk as outcome variance is inclusive of such diverse antisocial outcomes as crime, pathological gambling, and violence, as well as such diverse non-antisocial or prosocial outcomes as skydiving, stock market speculation, and firefighting, among many others (Holton, 2004; Mishra, 2014). We note that "prosocial" risk-taking has often been used to describe what are actually "non-antisocial" forms of risk-taking (e.g., such extreme sports as bungee jumping or skydiving; Wood, Dawe, & Gullo, 2013). We strictly define prosocial as positive, helpful, or cooperative social behaviors throughout this article (Barclay & Van Vugt, 2015).

Risk as outcome variance should not be confused with such similar concepts as hazard, danger, and uncertainty (e.g., Knight, 1921; Winterhalder et al., 1999). Hazardous and dangerous choices are those that may lead to (potentially severe) negative outcomes (i.e., downside risk; McNeil, Rudiger, & Embrechts, 2005). Risk is broader, in that it includes variance caused by either potential positive or negative outcomes. Uncertainty involves decision-making among options that have unknown decision outcomes. By contrast, risk canonically only involves choice among decision options with known variance. That is, decisions that are risky—but not uncertain—are made with complete knowledge of all possible outcomes and their probabilities (Knight, 1921; Tversky & Fox, 1995).

It has been argued that uncertainty can be considered to be a form of immeasurable risk (Knight, 1921). Given that risk and uncertainty are almost always present together in real-world situations, it follows that decision-making mechanisms should be calibrated to integrate both risk and uncertainty (Volz & Gigerenzer, 2012). A large body of evidence suggests that although exact known outcome distributions for decision options are almost non-existent in any domain of life, people make decisions *as if* they infer known distributions (e.g., Einhorn & Hogarth, 1985, 1986; Ellsberg, 1961; Rode, Cosmides, Hell, & Tooby, 1999). For example, Rode et al. (1999) demonstrated that people interpret uncertainty as a form of introduced outcome variance, and therefore, risk. Others have demonstrated that people make decisions that appear to be more sensitive to risk than uncertainty when both risk and uncertainty present together (e.g., Tversky & Fox, 1995). For ease of exposition, we proceed with the understanding that risk and uncertainty are largely inextricable in ecologically valid contexts and are generally integrated when people make real-world decisions (Volz & Gigerenzer, 2012). Although we focus on risk throughout this article, we clarify components of risk and uncertainty separately in the conceptual *relative state model* presented later in the article.

The broad definition of risk as payoff or outcome variance does not specify a particular currency of variance. Rather, this definition *assumes* a currency in the domain in which risk manifests. In some circumstances, this is not a serious conceptual issue; for example, if someone is deciding between purchasing a risky stock versus a low-risk savings bond, the currency of risk (i.e., money) is clear. However, the issue of currency of risk becomes more complicated when decision-makers face options that have impacts in multiple domains of life. For example, pathological gambling is clearly considered a form of risk-taking, in that pathological gambling necessarily involves consistent exposure of one's monetary resources to outcome variance (Mishra, Lalumière, & Williams, 2010). However, pathological gambling also has impacts in other domains of life (e.g., it can decrease social status and social support; it is strongly associated with stress, strain, and poorer mental and physical health; Ferland et al., 2008; Griffiths, 2004; Korn & Shaffer, 1999; Shaffer & Korn, 2002). In this example, pathological gambling is associated with higher outcome variance in multiple domains—financial, social, and health—but a single currency of variance is difficult to identify.

The most parsimonious definition of a single risk-taking currency may be biological fitness (e.g., Daly & Wilson, 2001; Houston, Fawcett, Mallpress, & McNamara, 2014; Mallpress, Fawcett, Houston, & McNamara, 2015; McNamara & Houston, 1986; Mishra, 2014; Wang, 2002). Humans and non-human animals are products of natural selection and therefore have been shaped over generations to behave in ways that appear to prioritize biological inclusive fitness (broadly defined as the reproductive success of self and kin who share genes; Hamilton, 1963, 1964). However, in humans, the pursuit of fitness rarely, if ever, is accomplished by making choices based on explicit calculations of likely fitness outcomes. Instead, organisms, including humans, tend to make decisions based on *proxies* of fitness, which are outcomes or currencies that were (or are) statistically associated with biological fitness, but not necessarily directly or linearly (Daly & Wilson, 2001; Kenrick et al., 2009; Mishra, 2014; Neuberg, Kenrick, Maner, & Schaller, 2004; Rode et al., 1999). Positive proxies of fitness include access to mates, resources, and high social status and/or good reputation; negative proxies include somatic damage, illness, and low social status and/or poor reputation. Returning to our earlier example, pathological gambling can be considered a risky behavior because it increases outcome variance with regard to such proxies of fitness as material resources, social status, and health. Risk can therefore be parsimoniously considered as outcome variance in proxies of fitness, which is the operational definition that we use throughout this article.

Two Pathways to Risk-Taking

Who engages in risk-taking, and under what conditions? Risk-taking has been historically characterized in the behavioral sciences as a product of stable individual differences in risk-propensity (e.g., Bromiley & Curley, 1992; H. J. Eysenck & Eysenck, 1985; S. B. Eysenck & Eysenck, 1977; Friedman & Savage, 1948; Mishra, Logue, Abiola, & Cade, 2011; Pratt, 1964; Roberts & DelVecchio, 2000; Slovic, 1964; Zuckerman, 2007). These stable individual differences have been typically considered to give rise to domain-general risk-taking, where some people are considered to be consistently risk-prone and others consistently risk-averse. Domain-specific approaches to risk-taking, such as the risk-return framework, have pushed back on this notion of stable trait risk-propensity, and instead conceptualize risk-taking as a product of estimated costs and benefits in different domains (e.g., Bell, 1995; Blais & Weber, 2006; Hanoch, Johnson, & Wilke, 2006; Johnson, Wilke, & Weber, 2004; Weber, Blais, & Betz, 2002; Weber & Hsee, 1998, 1999; Weber & Milliman, 1997). Importantly, much of this theorizing about domain-specificity and domain-generality has lacked a functional basis. We suggest that considering two (non-independent) pathways to risk-taking—need-based and ability-based—can help to clarify the etiology of risk-taking behavior broadly.

The need-based pathway describes a behavioral model whereby those who are competitively disadvantaged relative to others engage in risk-taking as a means of obtaining outcomes that might otherwise be unavailable or unattainable. The ability-based pathway describes a model whereby those who are competitively advantaged relative to others engage in greater risk-taking in domains where they possess special abilities because they have a greater chance of success and/or are able to signal abilities to others. It is important to note that we do not suggest that the need-based and ability-based pathways are independent; rather, we suggest that each pathway accounts for key variance in risk-taking. We offer a conceptual integration of the two pathways in our *relative state model* later in the article. We also later address how these pathways can help shed light on the domain-specific or domain-general nature of risk-taking, and how the model is relevant to understanding social behavior more generally.

Need-Based Risk-Taking

Risk-Sensitivity Theory and Need

The need-based account of risk-taking is based on *risk-sensitivity theory*, which predicts that human and non-human animals engage in risk-taking when low-risk options are unlikely to meet their goal (or desired) outcomes (Kacelnik & Bateson, 1997; Mishra, 2014; Mishra & Lalumière, 2010; Stephens, 1981; Stephens & Krebs, 1986). In such circumstances of disparity between one's present and desired or goal states—conditions of *high need*—risk-taking allows at least the possibility of obtaining otherwise unavailable or unattainable outcomes. Under conditions of *low need*—low disparity between one's present and desired or goal states—decision-makers should prefer relatively lower risk options.

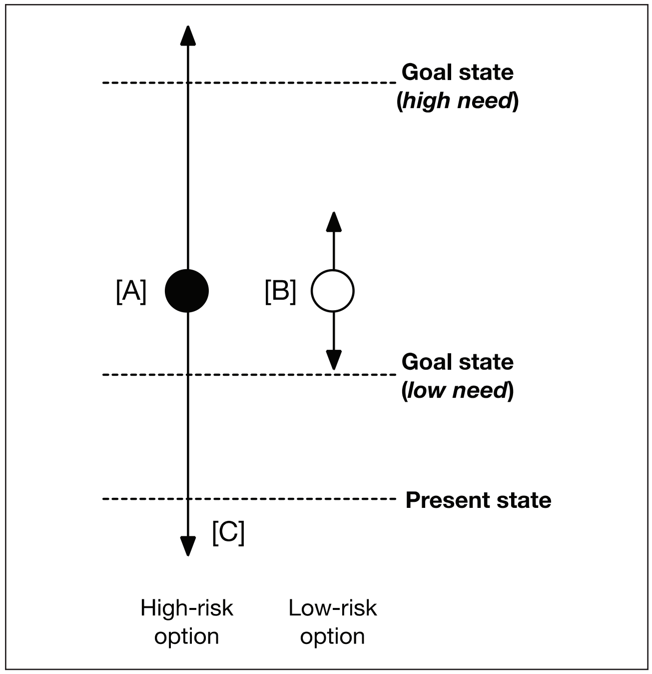

Figure 1. Risk-sensitivity theory.
Note. The black (white) circle represents the expected value of a high (low) risk option, and the arrows represent the variance of outcomes for each. When forced to choose between options of similar expected value but differing in risk (i.e., outcome variance), decision-makers should prefer high-risk [A] options in situations of *high need* (because it is the only option that offers a *chance* of meeting one's need) and prefer low-risk [B] options in situations of *low need* (to ensure the goal state is achieved and avoid unnecessary downside costs [C]).

A classic example is when a starvation threshold imposes caloric needs that promote foraging under predation risk. Faced with high caloric need, a starving organism's current fitness prospects are so poor that a failed foraging risk (i.e., death by predation) is no worse (in fitness terms) than its current trajectory (i.e., death by starvation). A needy organism thus has "nothing to lose" from a failed risk. By contrast, under low caloric need, sated decision-makers should not unduly expose themselves to unnecessary downside costs by choosing risky foraging options. Simply put, decision-makers should favor high-risk options in situations of *high need* (where low risk options are not able to meet this need) and low-risk options in situations of *low need* (thereby avoiding unnecessary downside costs). Risk-sensitivity theory is depicted visually in Figure 1.

The logic of risk-sensitive caloric foraging generalizes to the pursuit (avoidance) of many other positive (negative) fitness proxies. Someone with a pressing $50,000 debt owed to a violent loan shark, for example, might prefer a gamble offering a 10% chance of winning $50,000 instead of receiving $5,000 with certainty, even though both options offer the same expected value in the fitness proxy of money. The net fitness consequences of a $50,000 debt or a $45,000 debt (the outstanding debt minus the certain option's payoff) in this example are identical because the probability of serious bodily harm is equally likely in both scenarios. This example also illustrates the importance of recognizing diminishing marginal returns in all currencies. Past a need threshold (or any other reference point), each additional unit of any particular currency is worth less than the last (and the first unit that surpasses a need threshold is worth the most; Bernoulli, 1738). Similarly, approaching a need threshold involves accelerating marginal returns in the relevant currencies (e.g., Mishra & Fiddick, 2012; Mishra, Gregson, & Lalumière, 2012). A large and growing body of evidence suggests that people (and non-human animals) engage in risk-sensitive decision-making that is highly attuned to need thresholds, suggesting that risk-sensitivity theory is a powerful framework for understanding decision-making under risk in many different contexts (Deditius-Island, Szalda-Petree, & Kucera, 2007; Ermer, Cosmides, & Tooby, 2008; Gonzales, Mishra, & Camp, under review; Mishra, Barclay, & Lalumière, 2014; Mishra & Fiddick, 2012; Mishra & Lalumière, 2010; Mishra, Lalumière, Williams, & Daly, 2012; Mishra, Gregson, & Lalumière, 2012; Mishra & Novakowski, 2016; Mishra, Son Hing, & Lalumière, 2015; Pietras & Hackenberg, 2001; Pietras, Locey, & Hackenberg, 2003; Rode et al., 1999; Wang, 2002; reviewed in Bateson, 2002; Bateson, & Kacelnik, 1998; Kacelnik & Bateson, 1996, 1997; Kacelnik & El Mouden, 2013; Mishra, 2014).

Situational, Environmental, and Embodied Factors

In domains of social competition, those who are disadvantaged compared with more privileged others experience high need (Mishra et al., 2014; Mishra & Novakowski, 2016). Such conditions of need arise from both *situational or environmental factors* and *embodied factor*s, and are especially relevant in competition for key proxies of fitness (i.e., access to mates, material resources, social status, and reputation; Mishra, 2014; Mishra et al., 2014).

Environmental factors are aspects of the broader social and physical ecology that individuals operate in and situational factors are more specific characteristics of an individual's state. Situational/environmental factors collectively contribute to the perception of one's present and desired states. For example, in environments of intense economic competition (e.g., an environment with high income inequality), individuals with few economic resources may feel that they are distant from the desired economic state of more privileged, wealthy others. Poor individuals in such an environment would thus be competitively disadvantaged (Mishra, 2014; Mishra et al., 2014). In support of this hypothesis, evidence suggests that societal-level income inequality is associated with rates of various forms of risk-taking, including violence (Morenoff, Sampson, & Raudenbush, 2001), sexual promiscuity (Gold, Kennedy, Connell, & Kawachi, 2002), drug and substance abuse (Room, 2005), and crime (Daly & Wilson, 1988; Daly, Wilson, & Vasdev, 2001; Wilson & Daly, 1997; reviewed in Wilkinson & Pickett, 2009). Similar relationships between inequality (and analogues or consequences of inequality such as relative deprivation), competitive disadvantage, and risk-taking have been demonstrated at the individual level (e.g., Blalock, Just, & Simon, 2007; Callan, Ellard, Shead, & Hodgins, 2008; Chan, 2015; Ermer et al., 2008; S. E. Hill & Buss, 2010; Mishra et al., 2014, 2015; Mishra & Novakowski, 2016; Nunes & Pettersen, 2011).

Need can also manifest through embodied factors. Those who do not possess high levels of intelligence, for example, are less likely to find themselves in high paying jobs given that such jobs are typically cognitively complex (Ceci & Williams, 1997). In this example, competitive disadvantage for resource access (via high salaries and occupational prestige/status) manifests because of a largely stable embodied trait (low intelligence). The broad suite of embodied attributes that allow for successful social competition is known as *embodied capital* (Bourdieu, 2011; Kaplan, 1996; Kaplan & Gangestad, 2005; Kaplan, Gurven, & Winking, 2009; Lalumière, Harris, Quinsey, & Rice, 2005; von Rueden, Lukaszewski, & Gurven, 2015). Embodied capital is inclusive of such intrinsic individual differences as health, intelligence, attractiveness, and strength, among many others.

Situational/environmental factors and embodied factors necessarily interact: Someone who possesses low intelligence, for example, will be especially competitively disadvantaged—and even more likely to face needs that demand risk-taking—in a social environment characterized by high economic inequality (especially given that intelligence predicts earnings; Ceci & Williams, 1997). It is also important to note that although embodied capital, like personality, is largely stable, it can change over the lifespan due to situational factors (e.g., major illness or an accident). The relative level (and/or perception) of one's own embodied capital can also change due to environmental factors (e.g., by moving to a population characterized by a relatively higher or lower level of embodied capital), with resultant diverse (and differential) consequences for children and adults (e.g., Chetty, Hendren, & Katz, 2016; Kessler et al., 2014; Ludwig et al., 2012). The interaction of situational/environmental factors and embodied capital gives rise to what we call *relative state*, which is an assessment of an individual's competitive advantage or competitive disadvantage relative to others in the environment, and is what should drive risk-taking in response to social competition. We expand on the importance of relative state later in the article in our integrated conceptual model.

It is also important to acknowledge the importance of *social capital*, which is canonically defined as value derived from exchange relationships in social networks (reviewed in Adler & Kwon, 2002). People accumulate prestige-based social capital (and thus gain relational value; Leary, 2005) by leveraging embodied capital to share material and psychological resources with others. For example, providing social support to others is in part a consequence of possessing emotional intelligence; providing material support is in part a consequence of sharing money (or other resources) earned through leveraging various abilities (e.g., through one's job). Dominance-based social capital accrues to those who leverage embodied capital to deprive others of resources (Cheng, Tracy, Foulsham, Kingstone, & Henrich, 2013). For example, imposing costs on others (e.g., withholding valuable resources, inflicting somatic damage) is in part a consequence of physical strength and/or exploitative ability. Of course, social capital may also be derived from purely situational circumstances; one may possess resources as a consequence of good fortune (e.g., winning the lottery, hitting an oil well through dumb luck) and then leverage these resources into exchange relationships. Consequently, we consider social capital to derive from the interaction of embodied capital (i.e., embodied factors that increase relational value) and situational factors (i.e., in circumstances involving chance occurrences).

Situational and embodied factors are both associated with need and competitive (dis)advantage, and both have been in turn associated with risk-taking behavior consistent with risk-sensitivity theory (reviewed in Mishra, 2014). Next, we provide some examples of how the need-based pathway can shed light on different patterns of risk-taking. We begin by explaining how situational and embodied factors appear to influence antisocial risk-taking in different ways that map onto two clearly differentiated developmental patterns of antisocial behavior: adolescence-limited delinquency and life-course persistent offending (reviewed in Moffitt, 1993, 2003; Moffitt & Caspi, 2001; Moffitt, Caspi, Harrington, & Milne, 2002). We then describe how the need-based pathway can also account for non-antisocial risk-taking in various contexts.

Antisocial Risk-Taking

Adolescence-limited delinquency describes a pattern of typical antisocial behavior and risk-taking that is largely restricted to adolescence and early adulthood (reviewed in Moffitt, 1993, 2003; Moffitt & Caspi, 2001; Moffitt et al., 2002). This period (for many, the high school and college/university years) involves engagement in various forms of risk-taking, such as reckless driving, drug use and experimentation, and promiscuous sexual activity. The adolescent and early adulthood years are characterized by intense social competition for social status, mates, and resources (Daly & Wilson, 1988, 1997, 2001; Mishra, 2014; Mishra & Lalumière, 2008; Wilson & Daly, 1985). Teenagers and young adults who have not had time to accumulate skills, resources, or social status are at a steep competitive disadvantage to rivals who have. As a consequence of this competitive advantage, adolescents engage in elevated levels of risk-taking in an attempt to obtain social outcomes that may not be attainable through low-risk means, consistent with risk-sensitivity theory (Mishra, 2014).

Substantial evidence suggests that risk-taking propensity decreases across the lifespan cross-culturally (Dohmen et al., 2011; Mandal & Roe, 2014; reviewed in Mata, Josef, & Hertwig, 2016). As risk-takers meet their resource, social status, and mating needs over the lifespan (thus diminishing the experience or perception of competitive disadvantage), the necessity of risky behavior is reduced (Steinberg, 2007). For example, marriage and stable work are reliable correlates of desistance from risky behavior (Daly & Wilson, 2001; Mishra, 2014; Mishra & Lalumière, 2008). Those who lose this stability later in life (e.g., through divorce or being widowed) subsequently exhibit elevated risk-acceptance (Daly & Wilson, 1988, 2001). People of all ages are more likely to engage in risky aggressive and criminal conduct if they are unsuccessful at economic competition (e.g., if they are unemployed or expect poor future economic outcomes; S. E. Hill & Buss, 2010; Raphael & Winter-Ebmer, 2001; Wohl, Branscombe, & Lister, 2014) or at mating competition (e.g., if they are single or less attractive; Campbell, 1995; Chan, 2015; Daly & Wilson, 1990; Harris, Rice, & Lalumière, 2001; Mishra & Lalumière, 2008, Moffitt, 1993; Wilson & Daly, 1985). Temporally limited risk-taking behavior is therefore particularly effectively understood as a product of situational and environmental factors that facilitate social competition. These factors tend to be clustered in adolescence and young adulthood, but can occur later in life as well.

The second broad pattern of antisocial risk-taking is known as *life-course persistent offending* (reviewed in Moffitt, 1993, 2003; Moffitt & Caspi, 2001; Moffitt et al., 2002). Life-course persistent offenders show a pattern of consistent antisocial behavior across the entire lifespan: They are hyperactive, aggressive, and violent when young, and do not desist from antisocial behavior with age (reviewed in Moffitt, 1993, 2003; Moffitt & Caspi, 2001; Moffitt et al., 2002). These people are further characterized by broad and persistent social and biological adversity, leading to persistent competitive disadvantage. They are disproportionately likely to have experienced early life conditions leading to neurodevelopmental perturbations, including head trauma and brain injury, maternal substance abuse, and obstetrical complications (e.g., Neugebauer, Hoek, & Susser, 1999; reviewed in Anderson, 2007; Harris et al., 2001; Mishra, 2014; Mishra & Lalumière, 2008).

Biological (embodied) factors further interact with other social situational factors associated with antisocial behavior, including single-parent upbringing, low socioeconomic status, high economic inequality, and parental abuse (reviewed in Moffitt et al., 2002), further exacerbating competitive disadvantage. Early developmental environments ("sensitive windows") have been argued to be particularly important in that they can facilitate relatively permanent phenotypic changes in embodied capital that are less flexible to situational or environmental inputs later in life (e.g., Dietz, 1994; Fawcett & Frankenhuis, 2015; Gluckman & Hanson, 2004; Gluckman, Hanson, & Spencer, 2005; Nettle, Frankenhuis, & Rickard, 2013; Rickard, Frankenhuis, & Nettle, 2014). Collectively, these neurodevelopmental perturbations and disadvantaged social environments interact to produce pervasive competitive disadvantage through impaired cognitive abilities, increased impulsivity (i.e., disinhibited, present-oriented behavior), lower self-control (i.e., poorer executive control and self-regulation), increased delay discounting (i.e., preference for smaller present rewards over larger distal rewards) and decreased sensitivity to punishment (Frankenhuis, Panchanathan, & Nettle, 2016). These characteristics may in turn jointly lead to persistent risk-taking behavior across the lifespan (e.g., Frankenhuis & de Weerth, 2013; Moffitt et al., 2011).

Because life-course persistent offenders are so competitively disadvantaged, risk-taking behavior allows for obtaining resources or opportunities that might otherwise be unavailable or unattainable (consistent with risk-sensitivity theory; Mishra, 2014; Mishra et al., 2014). Antisocial behaviors such as the acquisition of resources through criminal means, establishment of dominance or status through violence, or sexual coercion in the pursuit of mating opportunities might represent the "best" behavioral options available to such disadvantaged individuals, regardless of how harmful such acts might be to others (Daly & Wilson, 1988, 2001; Mishra, 2014; Mishra & Lalumière, 2008; Wilson & Daly, 1985). If someone is able to legitimately compete for resources, status, or mates, it would not be beneficial to engage in costly antisocial risk-taking behavior because of the potential downsides. However, competitively disadvantaged individuals have much to gain and often little to lose from such conduct if their current trajectory is otherwise poor (e.g., Palmer & Tilley, 1995; Wilson & Daly, 1985; Yao, Långström, Temrin, & Walum, 2014; reviewed in Lalumière et al., 2005).

Persistent biological and social sources of competitive disadvantage are difficult to remedy. As a consequence, for disadvantaged individuals, antisocial risk-taking tends to remain stable across the lifespan (Mishra, 2014; Mishra & Lalumière, 2008; Moffitt, 2003; Moffitt & Caspi, 2001; Moffitt et al., 2002). Furthermore, once such risk-taking is initiated, the costs of unsuccessful efforts can exacerbate disadvantage, snowballing into further risk-taking. For example, someone who is convicted of and/or incarcerated for a crime early in life may experience fewer "safe" (i.e., low-risk) avenues for meeting one's needs after release (e.g., being unable to obtain gainful employment due to pervasive employer criminal record checks).

Non-Antisocial Risk-Taking

Need-based risk-taking can also manifest in non-antisocial domains. Risk-sensitivity theory (and thus the need-based pathway) is relevant to any form of risk-taking engaged in under conditions of need or competitive disadvantage, including "everyday" forms of risk-taking. For example, someone who needs to catch a bus but leaves home late may end up running in an attempt to get to his or her bus stop on time. In this example, there is a clear need (getting to work on time) and disparity between one's present and desired/goal states (being late vs. on time), which leads to a relatively risky behavior of running to the bus stop. Running is risky not only because of potential downside costs (e.g., harmful falls in icy winter conditions), but because it creates greater outcome variance: walking results in being late but rested, whereas running can either result in being on time (if successful) or late anyway and worse off because of exhaustion or injury (if unsuccessful).

Risk-sensitivity theory can also predict social forms of risk-taking; for example, some individuals might engage in non-antisocial risk-taking if they have social status or reputational needs that cannot be met with lower risk behaviors (e.g., singing karaoke to impress a potential mate, rather than just watching). Sports provide many examples of non-antisocial risk-taking due to need. These situations of risk-taking are not exclusive to special end-game circumstances such as a losing team abandoning defense of their goal to allow an extra offensive player in hockey or soccer. Need-based risk-taking also regularly occurs in more routine circumstances like American football teams using riskier passing plays more often when faced with high-need "3rd and long" situations (Gonzales et al., under review). These clarifications on the scope of the need-based pathway are particularly important because they highlight the broad explanatory power of risk-sensitivity theory not just in explaining antisocial risk-taking, but any forms of risk-taking that are made under some consideration of need or competitive disadvantage.

Ability-Based Risk-Taking

Just like a need-based perspective, an ability-based perspective on risk-taking considers the costs and benefits of risk. However, rather than focusing on some individuals having less to lose, an ability-based perspective emphasizes that some individuals are better able to reap the benefits or bear the costs of risk-taking. Such individuals may consequently be more willing to take risks because their expected payoffs are higher than for those who are likely to fail. For example, physically large individuals are more likely to win in physical confrontations (Sell, Tooby, & Cosmides, 2009), skilled rock climbers are less likely to fall on dangerous routes, and intelligent students are more likely to recoup the cost of student loans for university (Spence, 1975). Such individuals should therefore be more willing to take risks in those domains. In all of these examples, some individuals take more risks than others because they have some ability or trait that confers a higher probability of success, facilitates greater rewards for success, or reduces the harm caused by a failure.

These behaviors are still risky for these individuals—by definition—because they had alternative options with lower outcome variance (e.g., doing nothing).

A simple numerical example describes the key variables that serve as cost–benefit inputs for risk-taking: (a) probability of success, (b) probability of failure, (c) payoff (expected value) if one succeeds, and (d) payoff (expected value) if one fails. Imagine mountain climbers trying to decide between two options: climbing a mountain or not climbing a mountain. Compare a good mountain climber who has a 9/10 probability of succeeding at a dangerous climb and a bad climber who has a 1/10 probability of success. Suppose also that the payoff for successfully completing the climb is 100, the payoff for failing is 0, and the payoff for not attempting the climb is 50, such that success pays better than a non-attempt, which in turn pays better than a failure. Staying on the ground is the low-risk option: It guarantees a payoff of 50, with no variance in outcome (all else being equal). Climbing is by definition equally risky for the good and bad climber because they have equal variance in outcomes: a 9/10 probability of one outcome and 1/10 probability of the other, and this variance is greater than the variance associated with staying on the ground (0). The key difference between the two climbers' decisions is that the expected value per climb is higher for the good climber ($9/10 \times 100 + 1/10 \times 0 = 90$) than it is for the bad climber ($1/10 \times 100 + 9/10 \times 0 = 10$). Thus, compared with not climbing, it is risky for anyone to climb, but the expected payoff is higher for those who are more likely to succeed. This example also demonstrates the importance of distinguishing risk (variance in outcome) from expected value (average magnitude of outcome). We explicate these key input variables for risk-taking further in the conceptual *relative state model* presented later.

The ability-based perspective suggests that individuals who possess the qualities necessary to achieve success will disproportionately perform certain types of risk-taking. Many of these qualities are associated with high embodied capital. For example, safely competing in interpersonal conflict requires physical size and musculature, other physical capital (e.g., weaponry), or even social capital (e.g., coalitions; Archer, 2009; Fessler, Tiokhin, Holbrook, Gervais, & Snyder, 2014; Sell, Hone, & Pound, 2012). Dangerous physical activities like rock climbing or hunting require physical abilities like strength, agility, and coordination (Bliege Bird, Smith, & Bird, 2001; Smith & Bliege Bird, 2000; Smith, Bliege Bird, & Bird, 2003). Other risky behaviors require intelligence or special knowledge: Profitable investment requires knowledge of financial markets, successful hunting requires knowledge of good locations and prey behavior, and graduation from expensive universities requires intelligence and conscientiousness. Thus, we should expect those with higher embodied capital or social capital to perform certain kinds of risk-taking more often. This may seem to contradict our earlier assertions about risk-taking by those with low embodied capital, but the difference is in the *kind* of risky behaviors that people engage in. Those with special qualities or higher embodied capital should engage in forms of risk-taking that are more profitable as a consequence of possessing these traits (see Barclay & Reeve, 2012, for a similar argument about helpful behavior).

Low-cost risk-taking may also arise from having more "reserve" resources to absorb losses associated with failed risk-taking (Nettle, 2009). For example, rich venture capitalists are better able to invest in high-risk projects because a loss represents a lower proportion of their total wealth—They are gambling with their surplus, not their lunch money. Individuals with stronger immune systems can expose themselves to higher pathogen risk because they are better able to deal with an infection if they acquire one (Oaten, Stevenson, & Case, 2009). Well-liked people can afford to perform social risks like public speaking because others judge them less harshly for a bad speech. For all these individuals, negative outcomes in the relevant proxy currencies (money, pathogen load, reputation) have lower fitness impacts than they would for those without such "safety cushions." Those who have both the abilities required to provide a high expected payoff to a risky behavior and adequate "reserve" resources to cope with failed risks can repeatedly engage in that risky behavior, diversifying away much of their downside as they collect their benefits. This mechanism explains how well-capitalized casinos and bookmakers can reliably profit from offering risky bets—each of their risks have positive expected payoffs and they take enough independent risks that their aggregated actual payoffs approximate the expected payoffs.

Risk-Taking Signals and Partner Choice

The qualities that help in successful risk-taking—for example, physicality, intelligence, or attractiveness resulting from either embodied or social capital—are desirable traits in social partners because they are signals of one's ability to confer benefits to partners (Barclay, 2013, 2015). Audiences can therefore infer that a successful risk-taker is more likely to possess desirable qualities than an unsuccessful risk-taker, and that someone who willingly takes such risks probably has the qualities to do so successfully (e.g., Bliege Bird et al., 2001; Smith & Bliege Bird, 2000; Smith et al., 2003). For example, if you see someone successfully free-climb El Capitan, you can reasonably infer that he or she almost certainly has superhuman strength, endurance, and physical skill, all of which are desirable in coalitional or sexual partners. Conversely, if someone fails at an extraordinarily simple climbing task, or is unwilling to try, we can usually infer a lack of those qualities.

All else being equal, observers should prefer to pair with successful risk-takers over unsuccessful risk-takers, and should even prefer successful risk-takers over non-risk-takers, provided that the type of risk is easier to complete successfully for those of high quality. Observers benefit from choosing on this basis: It makes them statistically more likely to end up with a high quality partner, because the individuals taking the most risks (and consistently succeeding at them) will tend to be high quality individuals who can afford to do so. Of course, there are no guarantees in life because no one is omniscient, and occasional mistakes are inevitable (Todd, 2001), but such choices can be adaptive on average.

The qualities that facilitate successful risk-taking (physical, social, economic, intellectual) are also potential signals of one's formidability (Fessler et al., 2014); that is, one's ability to impose costs on others (which is different from one's willingness to do so; see Barclay, 2013, 2015). Formidable individuals are best placated instead of antagonized, and, may even make for useful allies who can impose costs on one's own enemies. Thus, people should be less likely to antagonize successful risk-takers, and may even prefer them as allies.

Being perceived as being formidable is a potential upside to antisocial or need-based risk-taking behaviors, in that such behaviors may confer some degree of dominance-based social status. Some evidence suggests that people are able to quickly and accurately infer personality traits or behavioral outcomes associated with antisocial risk-taking, providing further evidence for this signaling hypothesis. People are able to accurately infer drug use history, arrest history, physical violence, criminality, aggression, uncooperative or unethical behavior, gambling tendencies, future discounting tendencies, impulsivity, sensation-seeking, and low self-control from brief exposures to photographs, short videos, or voice recordings (Brown, Palameta, & Moore, 2003; Carré, McCormick, & Mondloch, 2009; Fetchenhauer, Groothuis, & Pradel, 2010; Haselhuhn & Wong, 2011; Little, Jones, DeBruine, & Dunbar, 2013; Mishra & Sritharan, 2012; Oda, Naganawa, Yamauchi, Yamagata, & Matsumoto-Oda, 2009; Puts, Apicella, & Cárdenas, 2011; Sell et al., 2010; Stillman, Maner, & Baumeister, 2010; Stirrat & Perrett, 2010; Tognetti, Berticat, Raymond, & Fauire, 2013; Valla, Ceci, & Williams, 2011; Verplaetse & Vanneste, 2010; Verplaetse, Vanneste, & Braeckman, 2007).

A preference for successful risk-takers can apply to romantic or non-romantic relationships because they both share similar properties (Barclay, 2013). In addition to the direct upsides of pairing with someone who can confer benefits, some of these traits are heritable in that they can be passed on to offspring genetically and/or culturally. Most traits, especially physical traits, are obviously influenced by genetics (Polderman et al., 2015), and offspring may also inherit the social conditions that lead to high embodied capital. For example, in some primate species, offspring inherit social capital such as social rank and coalition partners (Chapais, 1988; Cheney & Seyfarth, 2008). Human children can inherit monetary wealth as well, with resultant positive consequences (Bogerhoff Mulder et al., 2009). As a result, there are advantages to affiliating with those who possess the qualities necessary for successful risk-taking.

If observers prefer risk-takers as partners, individuals have an incentive to invest more effort in risk-taking to attract partners. Thus, risk-taking becomes a costly signal of one's ability to bear the costs of risk-taking. Costly signaling is a framework from evolutionary biology that offers one explanation for the existence of many costly traits, including lavish peacock tails, stotting displays (i.e., conspicuously jumping) to deter predators (Searcy & Nowicki, 2005; Zahavi & Zahavi, 1997), and even helpful behavior (Barclay, 2013; Gintis, Smith, & Bowles, 2001; Smith et al., 2003). The costly signaling approach suggests that individuals accept as high a level of risk that can safely be afforded, and audiences respond according to how much risk was accepted. The honesty of this signal is maintained by the cost or potential cost of its dishonest expression (Getty, 2006; Searcy & Nowicki, 2005; Higham, 2013): The long-term costs of repeated risk-taking would not be worth it for those who do not honestly possess the necessary skills or resources, as they will find themselves dead, broke, injured, outcast, or otherwise harmed by their eventual failure(s). By contrast, those who are sufficiently skilled can reap the long-term social rewards of being seen to possess desirable qualities, without failing so often or so badly that the risk-taking is unprofitable.

Examples of Ability-Based Risk-Taking

Many types of risk-taking may function (probably without awareness) as costly signals of important qualities such as physical skill, strength, intellect, or social clout. Many studies show that men accept higher risks when observed (especially by females) than when anonymous, including performing riskier driving (Chen, Baker, Braver, & Li, 2001; Williams, 2003), attempting riskier tricks on skateboards (Ronay & Von Hippel, 2010), preferring riskier hypothetical gambles (McAlvanah, 2009), accepting more risks in the Balloon Analogue Risk Task (Baker & Maner, 2009), and hesitating less when entering risky-looking virtual environments (Frankenhuis, Dotsch, Karremans, & Wigboldus, 2010). Correspondingly, audiences are more attracted to successful risk-takers (Farthing, 2005, 2007; Sylwester & Pawlowski, 2011; Wilke, Hutchinson, Todd, & Kruger, 2006), and male risk-takers are perceived as being taller, more muscular, and generally more formidable than low-risk men (Fessler et al., 2014). Antisocial risk-taking is less likely to attract partners because it demonstrates a lack of concern for others or poorer abilities (e.g., Mishra, Morgan, Lalumière, & Williams, 2010), but is still potentially useful for deterring competitors by signaling formidability (and therefore might have some value for attracting partners, such as for coalitional violence; Chagnon, 1997; Fessler et al., 2014).

Risk-taking can even be explicitly prosocial, such as taking risks to benefit others (Kafashan, Sparks, Rotella, & Barclay, in press). For example, jumping into a raging river to save a baby can signal one's physical abilities as well as one's concern for others (i.e., one's ability to help others and willingness to do so; Barclay, 2013). Firefighters regularly risk their lives to save others. Some evidence suggests that heroic risk-takers are also preferred as mates (Farthing, 2005). It is worth investigating what qualities are possessed by those who engage in such helpful risk-taking, especially volunteers who take risks without institutional compensation.

One well-studied example of prosocial risk-taking is hunting within foraging societies, especially the hunting of big game. This behavior is prosocial because hunted meat is often shared with others (for a review, see Gurven, 2004). It is risky because hunting has higher variance in outcomes than either gathering, hunting small game, or staying home (Hawkes, O'Connell, & Blurton Jones, 2014; Marlowe, 2010). When big game is caught, the result is a food bonanza. However, hunters are often unsuccessful: Many hunts result in no meat being caught (Hawkes et al., 2014; Marlowe, 2010), yet they still cost time, caloric energy, and opportunities to monitor one's mate against sexual infidelity. Consequently, relative to staying home, hunting can result in either a large net gain or loss in terms of time, energy, and paternity certainty. Anthropological research shows that better hunters tend to take this risk of hunting more often: The men who spend the most time hunting are those with the highest return rate per unit time (e.g., Bliege Bird et al., 2001). Others treat hunting ability as a signal of desirable qualities: Meriam turtle hunters have more attractive wives and higher reproductive success than non-hunters (Smith, 2004; Smith et al., 2003), and good Ache hunters have more extramarital affairs than poor hunters (K. Hill & Kaplan, 1988). These findings support the idea that people with high embodied capital will perform more prosocial risk-taking and will achieve fitness benefits from doing so.

Reconciling Pathways to Risk: The Relative State Model

Thus far, we have described two non-independent pathways to risk-taking: need-based and ability-based. The need-based pathway suggests that people engage in risk-taking in circumstances of competitive disadvantage or need consistent with risk-sensitivity theory. Those who are unable to obtain desired or goal outcomes with low-risk options (i.e., those who are competitively disadvantaged) should up-regulate preference for risk, which at least offers a chance to meet their needs and more successfully compete with others. Competitive disadvantage can manifest through situational factors (e.g., being poor in an environment of steep inequality) and embodied factors (e.g., phenotypic traits that confer long-term competitive disadvantage relative to others, such as low embodied capital).

The need-based pathway has underappreciated value for explaining antisocial risk-taking. Both situational/environmental and embodied factors that create competitive disadvantage can motivate antisocial risk-taking because competitive disadvantage may facilitate a more desperate interest in enhancing one's personal outcomes relative to (and potentially at the direct expense of) others. The need-based pathway can also account for engagement in prosocial or non-antisocial risk-taking if one experiences a need in a relevant domain (e.g., someone climbs a mountain to impress someone of the opposite sex who would not be impressed otherwise; asking someone out for a date).

The ability-based pathway suggests that people engage in risk-taking as an affordance of abilities or attributes that enable a greater probability of success, greater rewards for success, and/or a lower cost of failure from risky behavior. High embodied capital and positive situational factors (e.g., wealth) facilitate competitive advantage, which is associated with ability-based risk-taking for the types of risks that are made easier by that embodied capital (see also Barclay & Reeve, 2012). The ability-based pathway further suggests that people will be particularly likely to engage in forms of risk-taking that honestly signal desirable abilities, skills, or qualities to others, thereby facilitating social rewards. This signaling component of the ability-based pathway is particularly useful for explaining prosocial and non-antisocial forms of risk-taking, in that ability-based risk-taking tends to be widely appreciated or respected by audiences. However, the ability-based pathway can also account for engagement in antisocial behavior if such behaviors signal important abilities, skills, or qualities to others (e.g., engaging in a physical altercation to demonstrate formidability or dominance) or if their abilities make antisocial behavior more profitable.

Importantly, competitive advantage or disadvantage is necessarily relative, meaning that possessing high (or low) embodied capital does not necessarily guarantee that one will engage in solely prosocial (or antisocial) risk-taking. Broadly, risk-sensitivity theory dictates that those who perceive themselves to be relatively disadvantaged (whether or not this disadvantage is due to any embodied traits) will engage in risk-taking in the pursuit of goals that could not be otherwise obtained. It is therefore possible that someone who is privileged compared with many others—someone high in embodied capital or someone who possesses substantial wealth—may consider themselves to be competitively disadvantaged relative to even *more* privileged others (someone even higher in embodied capital or someone who possesses even more wealth). Such a mechanism may explain various forms of white-collar crime where those who are enormously wealthy engage in antisocial or risky behavior to obtain even greater wealth. Similarly, those who possess low embodied capital or relatively little by way of resources may not necessarily engage in greater risk-taking if they are among others who are in a similar situation (e.g., in a low inequality environment) or among those who are relatively worse off.

The Relative State Model

We have emphasized throughout the article that the need-based and ability-based pathways are not independent.

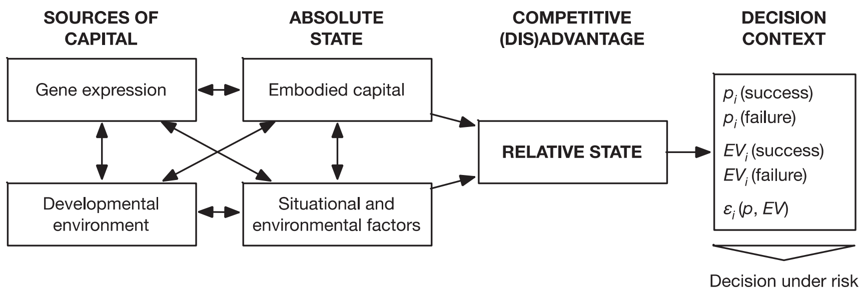

Figure 2. The relative state model.
Note. EV = expected value. For each choice *i* (from 1 to *n*, where *n* represents the number of choices in a context): (a) p_i (success) and p_i (failure) are the estimated probabilities of success and failure, respectively; (b) EV_i (success) and EV_i (failure) represent estimated expected values of success and failure, respectively; (c) ε_i describes uncertainty regarding exact estimates of probabilities and expected values. Decision-makers should prefer, on average, choices within decision contexts that maximize estimated p_i (success) and/or minimize p_i (failure), as well as maximize estimated EV_i (success) or minimize EV_i (failure) given their own relative state.

Embodied capital and situational/environmental factors (and their interaction) are key inputs that can facilitate *both* competitive advantage and competitive disadvantage. In some ways, the need-based pathway and the ability-based pathway are corollaries of each other; the need-based pathway largely focuses on the motivational effect of competitive disadvantage (and subsequent risk-taking as cost mitigation) whereas the ability-based pathway largely focuses on the motivational effect of competitive advantage (and subsequent risk-taking as benefit-seeking).

Here, we provide a single conceptual model—the *relative state model*—that integrates both pathways and provides novel predictions about any behaviors that involve risk. Broadly, this model suggests that organisms make risk-relevant decisions sensitive to (a) their *relative state*—which is a computation of competitive (dis)advantage derived from the interaction of embodied and situational/environmental factors, (b) the probability of success or failure of various decision options (including "sitting out"), and (c) the expected values of success and failure for each decision option. Decision-makers should favor decision options that maximize the estimated probability of success, minimize the estimated probability of failure, and maximize the estimated expected value (given their own relative state) of any given risk. This model is summarized in Figure 2. Although we discuss "success" and "failure" as binary discrete outcomes, our point generalizes to different gradations of success and failure. In the following, we describe each portion of the model in more detail.

Sources of capital. All phenotypic traits are a necessary product of gene-environment interaction (reviewed in Ridley, 2003; Rutter, 2006); these include the broad suites of traits that comprise embodied capital. The interaction of gene expression and environmental and situational factors is further complicated by the fact that environments are in part a consequence of gene expression (through niche construction; reviewed in Laland, Odling-Smee, & Feldman, 2000; Odling-Smee, Laland, & Feldman, 2003), and that environments also affect gene expression (through epigenetic processes; reviewed in Bird, 2007; Goldberg, Allis, & Bernstein, 2007). Gene expression can have wide-ranging consequences on risk-taking behavior (Anokhin, Golosheykin, Grant, & Heath, 2009; Lalumière, Mishra, & Harris, 2008; Lyons et al., 1995). Psychopathy—a pattern of persistent and extreme risk-taking over the lifespan that appears to be largely genetically driven (e.g., Larsson, Andershed, & Lichtenstein, 2006)—is a particularly good example (reviewed in Lalumière et al., 2008). Hence, the first stage of our model acknowledges that embodied capital is the product of the complex interaction of gene expression, developmental environment, and situational/environmental factors (as noted above, embodied capital can change over the lifetime, for example, from an accident or via senescence).

Absolute state. We conceive of an individual's *absolute state* to be the consequence of the interaction of a decision-maker's embodied capital and the situation or environment of decision-making. In an absolute sense, people's embodied capital can range from very low (e.g., low intelligence, attractiveness, strength) to very high (e.g., high intelligence, attractiveness, strength). These traits manifest in such objectively quantifiable outcomes as cognitive ability (intelligence), facial symmetry (attractiveness), and weight-lifting ability (strength), among many others. Similarly, people's situations can range from very poor (e.g., possessing few resources, living in an environment with high extrinsic mortality) to very good (e.g., being rich, living in an environment with low extrinsic mortality), all of which can also be objectively quantified.

Relative state and competitive (dis)advantage. Competitive advantage or disadvantage is necessarily determined through some form of comparison—either with others (e.g., being richer than others) or with a different state an individual has experienced (e.g., being hungry or thirsty).

Table 1. Competitive (Dis)Advantage for Oneself Is a Function of One's Own Embodied Capital and the Capital of Average Competitors in a Particular Environment.

	Self	
	High EC	Low EC
Average competitor		
High EC	No competitive (dis)advantage	Competitive disadvantage
Low EC	Competitive advantage	No competitive (dis)advantage

Note. EC = embodied capital.

We propose that decision-makers compute an estimated index of *relative state*—where one stands once the interaction of embodied capital and one's specific situation is considered. Someone who is high in relative state would be competitively advantaged compared with average competitors (e.g., they are smarter, more attractive, and/or stronger than others around them). Conversely, someone who is low in relative state would be competitively disadvantaged relative to average competitors (e.g., they are less smart, less attractive, and/or less strong than others around them). In all conditions, relative state depends on some comparison of present and desired states (either determined internally or externally).

For example, people who possess high (low) embodied capital in an environment where average social competitors also possess high (low) embodied capital are not relatively competitively advantaged or disadvantaged (e.g., an attractive, intelligent university student in an environment full of other similar university students is not competitively (dis) advantaged). However, someone who possesses high embodied capital in an environment where average others are not so fortunately endowed (e.g., an elite athlete in an introductory fitness class at the community gym) is competitively advantaged. Similarly, someone who possesses low embodied capital in an environment where average others possess high embodied capital (e.g., an introductory mountain climber at a party for those who have climbed Mount Everest) is competitively disadvantaged. These possibilities are summarized in Table 1.

Proximate affective mechanisms likely provide an estimated "barometer reading" of one's own relative state. For example, growing research has demonstrated that subjective relative deprivation—feelings of resentment, dissatisfaction, and anger association with perceived deprivation of a deserved outcome relative to others (Bernstein & Crosby, 1980; Runciman, 1966; Smith, Pettigrew, Pippin, & Bialosiewicz, 2012)—are associated with competitive disadvantage (e.g., Mishra & Novakowski, 2016), with negative downstream health and social consequences (reviewed in Callan, Kim, & Matthews, 2015; Mishra & Carleton, 2015; Mishra & Novakowski, 2016).

Decision context. The final component of the relative state model is decision context. Frameworks for understanding the domain-specificity of risk-taking (reviewed later) suggest that decision-makers compute the estimated costs and benefits of various behaviors (decision options) in any given domain leading to a decision under risk (i.e., a choice between various decision options with variable outcomes). We specify this conceptualization further and suggest that decision-makers implicitly estimate costs and benefits of various behaviors (decision options) in any specific *decision context*. Specifically, we suggest that decision-makers implicitly compute, for each decision option available to them (or each decision option they are *aware* of being available to them) within a particular decision context (a) the probabilities of success and failure and (b) the expected values (in fitness returns) of success and failure (as summarized above in our earlier mountain climbing example). Finally, we introduce an error term that acknowledges uncertainty in the (perceived) estimates of probabilities and expected values of different decision options.

In our model, we suggest that decision-makers perform some integration of perceived probabilities and expected values of possible outcomes that is then acted on through option choice. We do need to be clear, however, that terms like *compute* and *integrate* are not intended to imply conscious evaluation processes. Few decisions are made with explicit awareness (i.e., most decisions are made implicitly based on previous experiences, known as decision-making from experience; for example, Hertwig, Barron, Weber, & Erev, 2005). Rather, people likely respond to the affective appraisal of different decision options, consistent with a "risk-as-feelings" account (Loewenstein, Weber, Hsee, & Welch, 2001). We focus on the functional logic of risk-taking, which can inform further investigation of the proximate cognitive mechanisms, but is not our goal here to characterize those mechanisms; for comprehensive reviews of some proposed proximate risk mechanisms, see, for example, Bechara and Damasio (2005), Lerner and Keltner (2000), Loewenstein et al. (2001), Schwarz (2000), and/or Slovic (2000).

Domain-Generality and Domain-Specificity of Risk

One of the most important problems that the relative state model can clarify is when risk-taking will appear domain-specific and when it will appear domain-general. There is a long-standing debate in the behavioral sciences as to whether risk-taking co-occurs across multiple contexts or domains (i.e., is domain-general) or is restricted to particular contexts or domains (i.e., is domain-specific). Here, we summarize the arguments for the domain-general and domain-specific conceptualizations of risk, and then describe how the relative state model can reconcile these two conceptualizations.

Domain-General Approaches to Risk

Risk-propensity has been historically understood as a stable, individual-level, domain-general trait, especially in economics and psychology (e.g., Bromiley & Curley, 1992; H. J. Eysenck & Eysenck, 1985; S. B. Eysenck & Eysenck, 1977; Friedman & Savage, 1948; Mishra, 2014; Mishra, Logue, et al., 2011; Pratt, 1964; Roberts & DelVecchio, 2000; Slovic, 1964; Weber, 1998; Weber et al., 2002; Zuckerman, 2007). Several personality traits—especially sensation-seeking, impulsivity, and low self-control—have been consistently associated with various forms of risk-taking (e.g., Grasmick, Tittle, Bursik, & Arneklev, 1993; Jones & Quisenberry, 2004; Junger & Tremblay, 1999; Mishra, Lalumière, Morgan, & Williams, 2011; Mishra, Lalumière, & Williams, 2010; reviewed in Gottfredson & Hirschi, 1990; Lalumière et al., 2005; Moffitt et al., 2002; Zuckerman, 2007). Mishra and Lalumière (2011) presented evidence that a single principal component ("risky personality") accounts for large portions of overlapping variance (i.e., greater than 60%) between self-reported trait measures of impulsivity, sensation-seeking, and low self-control, and that this overarching component is associated with behavioral risk-taking. Furthermore, individual differences in behavioral risk-propensity (i.e., stable patterns of risk-taking across contexts) have been identified among non-human animals, suggesting that a trait approach to risk-propensity is broadly relevant across taxa and not unique to humans (reviewed in Mishra, Logue, et al., 2011).

One of the most prominent applications of a trait-based understanding of risk-propensity is the *generality of deviance* framework. This framework suggests that there are individuals who persistently engage in various forms of antisocial risk-taking (i.e., high outcome variance behaviors that involve harm to oneself or others) and that these behaviors are associated with stable individual differences (e.g., low self-control; Gottfredson & Hirschi, 1990; Hirschi & Gottfredson, 1994). In support of the generality of deviance hypothesis, substantial evidence demonstrates that various forms of antisocial risk-taking behavior co-occur within individuals, including violence, criminal behavior, illicit substance use, dangerous driving, pathological gambling, and sexual risk-taking and aggression, among many other behaviors (e.g., Arneklev, Grasmick, Tittle, & Bursik, 1993; Donovan & Jessor, 1985; Farrington, 1995; Grasmick et al., 1993; Hirschi & Gottfredson, 1994; Jones & Quisenberry, 2004; Mishra, Lalumière, & Williams, in press; Mishra, Lalumière, & Williams, 2010; Mishra, Lalumière, et al., 2011; Moffitt et al., 2002; Osgood, Johnston, O'Malley, & Bachman, 1988; reviewed in Mishra, 2014; Mishra & Lalumière, 2009; Williams, Royston, & Hagen, 2005; Zuckerman, 2007). Furthermore, people who engage in these various forms of antisocial risk-taking also possess high levels of trait impulsivity and low levels of trait self-control (reviewed in Lalumière et al., 2005; Moffitt et al., 2002; Zuckerman, 2007). Together, this body of evidence suggests that various forms of antisocial risky behavior tend to co-occur among individuals, and that this co-occurrence is partly underpinned by stable personality traits. Those who argue that risk is domain-general largely focus on the generality of deviance (and the individual differences that give rise to general antisocial risk-taking; for example, Gottfredson & Hirschi, 1990; Hirschi & Gottfredson, 1994; Zuckerman, 2007). However, these researchers generally do not consider non-deviant forms of non-antisocial or prosocial risk-taking.

Domain-Specific Approaches to Risk

Growing evidence and theorizing suggests that if non-deviant risk-taking is included, people show elevated risk-taking behavior in some domains, but not others (e.g., Blais & Weber, 2006; Hanoch & Gummerum, 2011; Hanoch, Johnson, & Wilke, 2006; Johnson et al., 2004; Kruger, Wang, & Wilke, 2007; Levenson, 1990; Soane & Chmiel, 2005; Wang, Kruger, & Wilke, 2009; Weber et al., 2002; Weller & Tikir, 2011). For example, some individuals engage in high levels of recreational and sport-related risk-taking, but low levels of financial risk-taking (Hanoch et al., 2006). Others engage in high levels of antisocial risk-taking (consistent with a generality of deviance account), but low levels of prosocial risk-taking (e.g., Gomà-i-Freixanet, 1995, 2001; Levenson, 1990; Wood, Dawe, & Gullo, 2013). Collectively, these findings suggest a certain degree of domain-specificity in risk-taking. Two major theoretical frameworks have been widely used to explain (and predict) domain-specific risk-taking: The risk-return framework, and a suite of interrelated evolutionary approaches to domain-specificity.

The risk-return framework posits that individuals vary in their perceptions of the costs and benefits of risk-taking, and that they engage in risk-taking in domains where the estimated benefits of risk-taking outweigh the estimated costs (e.g., Bell, 1995; Weber, 1997; Weber, 2001; Weber & Hsee, 1998; Weber & Milliman, 1997). Consistent with this risk-return account, it has been shown that people systematically vary in their perceptions of the costs and benefits of risk-taking in various domains (e.g., Bontempo, Bottom, & Weber, 1997; Johnson et al., 2004; Weber, 1988), and that people appear to make risk-sensitive decisions in a domain-specific manner (e.g., Bell, 1995; Blais & Weber, 2006; Hanoch, Johnson, & Wilke, 2006; Johnson et al., 2004; Weber et al., 2002; Weber & Hsee, 1998, 1999; Weber & Milliman, 1997).

Many studies examining domain-specificity have centered on administration of the Domain-Specific Risk-Taking Scale (DOSPERT), which measures risk perception and risk-propensity in a number of domains of life: ethical, financial, health/safety, recreational, and social (Blais & Weber, 2006; Weber et al., 2002). Research using the DOSPERT shows that individuals appear to exhibit substantial differences in which domains they take the most risks (although it should be noted that risk-taking still tends to be highly inter-correlated across all of the sub-domains of the DOSPERT scale, suggesting that stable individual differences in risk-propensity still play an important role). Different subsamples of risk-takers have also been shown to engage in different patterns of risk-taking. For example, extreme sports participants report high levels of recreational risk-taking, but low levels of financial risk-taking (Hanoch et al., 2006).

Evolutionary approaches to understanding domain-specificity are similar to the risk-return approach, except that costs and benefits of risky behavior are defined around a biological understanding of what constitutes adaptive, evolutionarily "rational" behavior (e.g., Haselton et al., 2009; Kenrick et al., 2009; Mishra, 2014; Todd, 2000; Todd & Gigerenzer, 2012). Evolutionary approaches posit that people engage in behaviors that would have been historically associated with positive differential reproductive success and inclusive fitness (i.e., biological fitness either for oneself or for close relatives; Hamilton, 1963, 1964). Evolutionary psychologists have recently constructed a measure of domain-specific risk-taking guided by life history theory (Kruger et al., 2007). Life history theory is a developmental framework for understanding how organisms allocate time and energy among essential biological functions (reviewed in Del Giudice, Gangestad, & Kaplan, 2015; Kaplan & Gangestad, 2005; Stearns, 1992; Stearns, Allal, & Mace, 2008). Research involving the evolutionary domain-specific risk-taking scale provides further evidence in support of the notion that people are domain-specific risk-takers. Wang et al. (2009) showed that levels of risk-taking in these various evolutionarily relevant domains vary based on predictable life history characteristics. For example, parenthood is associated with reduced within-group and between-group risky competition.

The risk-return and evolutionary frameworks for understanding domain-specific risk-taking are similar in that they both posit that individuals make separate domain-specific calculations of the estimated costs and benefits of various risky behaviors. However, the frameworks differ in how they conceptualize how people perceive different domains, and how to define the currency used to calculate costs and benefits. Evolutionary approaches suggest humans and non-human animals "carve up" the world around them into functional categories (i.e., in terms of fitness proxies), whereas the risk-return framework is agnostic about how people distinguish domains of risk-taking and about what currency (or currencies) people use to calculate costs and benefits. Regardless of the differences between the frameworks, it is clear that people are to some extent domain-specific risk-takers, regardless of how domains are defined.

The Relative State Model, Dual Pathways, and Domain-Specificity/Generality

The relative state model can neatly account for the empirical patterns of domain-specificity and domain-generality of risk-taking described above. The need-based pathway suggests that people should engage in risk-taking only in those domains where they are competitively disadvantaged, consistent with risk-sensitivity theory. Such behavior would give rise to the appearance of domain-specificity. Conversely, risk-taking would appear domain-general under conditions where an individual is competitively disadvantaged in multiple domains or if a general need can be ameliorated by risk-taking in any of a number of domains. For example, someone who is competitively disadvantaged might be more likely to engage in risk-taking in social domains (e.g., violence, interpersonal confrontation), economic domains (e.g., lotteries), and sexual domains (e.g., sexual aggression), and hope that risk-taking in at least one of these domains will provide an adequate payoff. The ability-based pathway suggests that people should engage in risk-taking in domains where they are competitively advantaged (i.e., in domains where they possess the ability to successfully engage in risk-taking behavior without incurring exorbitant costs). Domain-generality would be observed if people possess abilities that are relevant to multiple domains of risk-taking. In sum, whether such individuals' risk-acceptance generalizes to other domains should depend on whether those other domains are also affected by the same qualities, expertise, and relative condition.

Earlier, we provided evidence showing that competitive disadvantage gives rise to various forms of antisocial risk-taking in multiple domains. Competitive disadvantage stemming from either situational or embodied factors typically spans multiple domains: Teenagers and young adults find themselves in an environment of high social competition where their relative competitive disadvantage manifests through lesser financial resources, poorer skills, and lesser attractiveness, among many other factors (Daly & Wilson, 1988; Mishra, 2014; Wilson & Daly, 1985). Similarly, people who are competitively disadvantaged because of embodied traits are rarely only disadvantaged in a single domain: Various facets of embodied capital—attractiveness, intelligence, physical ability, and strength—tend to be at least somewhat associated with each other, and with such key outcomes as income (e.g., Honekopp, Bartholome, & Jansen, 2004; Honekopp, Rudolph, Beier, Liebert, & Muller, 2007; Judge, Hurst, & Simon, 2009; Kanazawa, 2011; Langlois et al., 2000; Postma, 2014).

We can also illustrate domain-generality using examples of competitive *advantage*, such as if someone possesses special qualities or abilities. If a single quality can reduce the cost of different kinds of risk-taking behaviors (e.g., if physical coordination reduces the cost of both rock climbing and cliff diving), then such behaviors would "cluster" together. In this example, both risks are physical, so the same quality (coordination) could affect both and the people who do one might be more likely to do the other. This logic generalizes to many types of social behavior. Possessing wealth can affect one's willingness to play the stock market and to speculate on real estate because both of these behaviors are financial risks and are both less dangerous for people with wealth to spare. Larger members of a species may be more willing to engage in confrontations with both conspecifics and predators because their large size will help them in both types of confrontation. Whenever one quality—whether involving financial, physical, intellectual, or social capital—can affect multiple types of risk, then any individual who possesses that quality should be more willing to take any risks that are aided by that quality, giving rise to correlated risk-taking across multiple contexts and thus the appearance of domain-generality.

However, some types of ability-associated risk are clearly different from one another and require very distinct skillsets. Physical confrontations require size and fighting ability, extreme skiing requires coordination and many hours on skis, public speaking requires intelligence and possibly social influence, and financial investment requires wealth and financial acumen. Possession of one of these skills does not imply possession of the others—there is no a priori reason to suggest that large individuals will be more intelligent or coordinated, for example. Some specific types of risk involve expertise developed through long practice: It requires many practice hours to be a good rock climber, and there is no reason to expect the same person to have many hours of expertise in choosing risky stock options. Insofar as these different domains of risk require different skillsets, risk-acceptance in one should not generalize to another domain, and indeed, the evidence reviewed above suggest they do not.

In sum, the domain-specificity or domain-generality of ability-based risk-taking depends (at least in part) on the domain-specificity or domain-generality of relevant skills or qualities. If two types of risk are affected by the same qualities or skillset, then we predict that they will be more likely to be performed by the same type of person (domain-general risk-taking). When they require different qualities or skillsets, then we predict that a person's risk-taking will be confined to their area of "specialty" (domain-specific risk-taking).

We can now "zoom out" and provide a more general set of conditions that should lead to domain-specificity or domain-generality independent of pathway. People should engage in greater risk-taking when, all things being equal, (a) the probability of success is relatively high, (b) the probability of failure is relatively low, and (c) the expected value of successful risk-taking is relatively high, (d) the expected value of unsuccessful risk-taking is relatively high, and (e) the expected value of alternate options (e.g., doing nothing) is relatively low. These probabilities and expected values are dictated by one's relative state in a particular context (which has embodied and situational/environmental inputs, as described earlier). Domain-generality should be observed across contexts or domains where the five parameters described above (probability of success and failure; expected values of success, failure, and alternate options) are highly correlated. That is, if there are similar costs and benefits to engaging in risk-taking across multiple contexts or domains, then we should observe domain-general risk-taking. For example, if physical confrontations and prosocial norm enforcement share the same causal pathway (e.g., physical formidability; Lukaszewski, Simmons, Anderson, & Roney, 2016), then risk-taking will appear domain-general across those contexts. By contrast, domain-specificity should be observed across contexts where the costs and benefits of risk-taking do not similarly translate. These predictions are entirely consistent with the risk-return framework, although our model provides a functional explication of the sources of costs and benefits involved in risk-taking. The conditions that lead to domain-general and domain-specific risk-taking are summarized in Figure 3.

Theoretical and mathematical modeling work is necessary to understand how relative state translates into either domain-specific or domain-general risk-taking. Specifically, it would be interesting to examine state-dependent optimization mechanisms through these methods (e.g., McNamara, 1998). This work may involve gaining a greater understanding of when people will prefer higher-value options (as predicted by expected utility theory; Friedman & Savage, 1948, 1952) and when they will prefer higher-variance options (as predicted by risk-sensitivity theory; Houston et al., 2014; Mallpress et al., 2015; Mishra, 2014). Importantly, a fuller understanding of how need-based and ability-based risk-taking interact can help integrate two major classes of theories in decision research—expected utility and risk-sensitivity theories—and further our understanding of when risk-taking will span domains or be limited to a single domain.

Implications for Broader Social Behavior

The relative state model has important implications for understanding social behavior broadly. It is necessarily true that risk is inherent in any form of behavior, in that all behavior involves some outcome or payoff variance. Even the simplest decisions involve a choice between doing nothing and doing something, which necessarily involves variance in outcome, and thus, risk (Mishra, 2014). In the following, we describe how the relative state model can be used to understand behavior in three key domains of social behavior: cooperation, conflict, and mating.

Cooperation

Cooperation necessarily involves risk: When two or more individuals cooperate for mutual benefit, all can be better off than if none had cooperated. However, there is some threat that one's partner(s) might not reciprocate, leaving one worse off than before (Axelrod, 1984; Trivers, 1971). Who is most likely to take the risk of cooperation? There are several possibilities. People in high need may cooperate more because it represents the only way of surviving hostile and unpredictable environments (e.g., through food sharing; Cashdan, 1985; Gurven, 2004). Alternatively, people in low need—those with high embodied and social capital—may cooperate

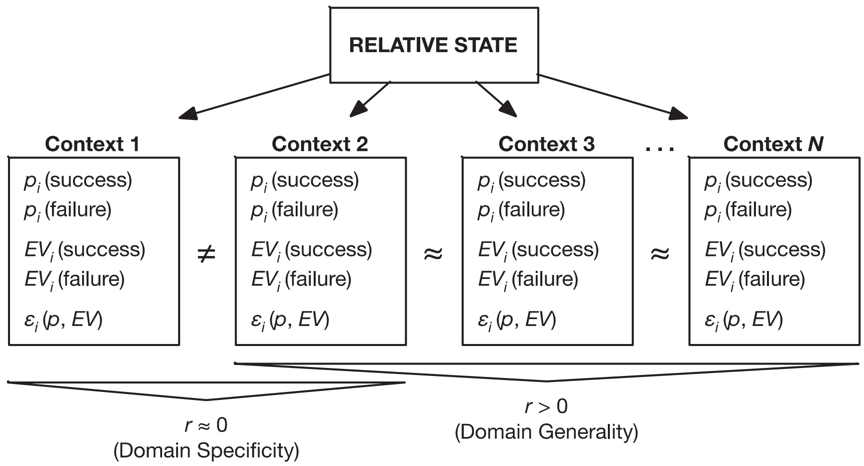

Figure 3. How relative state can give rise to the appearance of domain-generality or domain-specificity of risk-taking across contexts or domains.

Note. EV = expected value. Here, contexts span from 1 to *N*. If costs and benefits are not correlated across contexts (as illustrated here by Contexts 1 and 2), domain-specific risk-taking would be observed. If costs and benefits are correlated across contexts (as illustrated here for Contexts 2 and 3), domain-generality of risk-taking would be observed. For each choice *i* (from 1 to *n*, where *n* represents the number of choices in a context): (a) p_i (success) and p_i (failure) are the estimated probabilities of success and failure, respectively; (b) EV_i (success) and EV_i (failure) represent estimated expected values of success and failure, respectively; (c) ε_i describes uncertainty regarding exact estimates of probabilities and expected values. The correlation of probabilities and expected values across contexts is denoted by *r*.

more because they can do so at lower cost or because they can afford to be cheated occasionally (Nettle, Colléony, & Cockerill, 2011; reviewed in Kafashan, Sparks, Griskevicius, & Barclay, 2014), and may even use cooperation as a signal of their qualities (e.g., Roberts, 1998). A third possibility is that people with high capital may cooperate less because they can afford the social costs of cheating others (Barclay, 2013; Piff, Stancato, Côté, Mendoza-Denton, & Keltner, 2012; reviewed in Kafashan et al., 2014).

The relative state model can help shed light on this debate by recognizing how relative need and relative abilities affect the probability of success (a) and failure (b) at risky cooperation, the payoffs for successful risky cooperation (c), the payoffs for unsuccessful risky cooperation (d), and the payoffs for one's non-risky options (e). For any type of risky cooperation, the answer to who helps most will depend on how one's relative state affects each of these five parameters (see also Barclay & Reeve, 2012). For example, if high relative state makes one more likely to succeed (e.g., hunting and sharing meat), then those with high relative state will be more likely to take that risk. Low embodied capital will hinder cooperation among people who cannot afford to be cheated by a partner (a costly outcome for unsuccessful risk-taking), but will promote cooperation among people who have great need of mutual cooperation (a lucrative outcome for successful risk-taking) or are desperate enough that they would not survive without mutual cooperation (a costly outcome for choosing a non-risky option).

Risk is also involved in the building and maintenance of one's reputation as a cooperator. In a world where reputation matters, cheating others is a risky choice: One can save the cost of cooperation if successful, but if unsuccessful, one can destroy one's reputation and thus one's future relationships. Correspondingly, we have found that risk-takers are more likely to defect in a public (but not private) Prisoner's Dilemma game than non-risk-takers (Sparks, Mishra, Rotella, & Barclay, in preparation). Relative state is relevant here because one's "market value" as a partner affects whether one can afford the reputational loss of being seen to cheat others (Barclay, 2013, 2016).

Conflict

Interpersonal conflict and aggression are obvious forms of risk-taking. Such behaviors offer potential downsides, including both physical and social (e.g., reputational) harm to self and others, as well as possible upsides, including the gaining (or signaling) of social status, dominance, and formidability (Benard, 2013; Daly & Wilson, 1988; Felson, 1978; Fessler et al., 2014; Frank, 1988; Griskevicius et al., 2009; Johnstone & Bshary, 2004). Decisions to engage in interpersonal conflict and aggression are contingent on one's own competitive (dis)advantage, and as a consequence, both the need-based and ability-based pathways of the relative state model can shed light on who engages in interpersonal conflict and aggression.

As reviewed above, people who are most likely to engage in antisocial risk-taking (including aggression and criminal conduct) are those who are competitively disadvantaged relative to others (e.g., Campbell, 1995; Chan, 2015; Daly & Wilson, 1990; Harris et al., 2001; S. E. Hill & Buss, 2010). "Young male syndrome," for example, describes the observation that those who are under the most intense reproductive competition (typically, young males) are more likely to engage in various forms of risk-taking, including crime, gambling, and daredevilry (Daly & Wilson, 1988, 1997, 2001; Mishra, 2014; Mishra & Lalumière, 2008; Wilson & Daly, 1985). Similarly, those who are chronically competitively disadvantaged as a consequence of early neurodevelopmental perturbations or poor social developmental environments engage in a persistent pattern of antisocial risk-taking across the lifespan (reviewed in Eme, 2009; Harris et al., 2001; Mishra & Lalumière, 2008; Moffitt et al., 2002; Rutter, 1997). Competitively disadvantaged individuals are at a lower relative state compared with others, and may thus engage in risk-taking because the payoffs of such behavior given their own circumstances are higher. These observations are all consistent with the need-based pathway.

Conversely, competitive advantage can also be associated with interpersonal conflict and aggression. Those who are particularly large or strong, for example, may engage in antisocial behavior to signal dominance and/or formidability (e.g., Johnstone & Bshary, 2004; Sell et al., 2009), both of which confer social status (reviewed in Barclay, 2015). In the terms of the relative state model, such individuals would likely perceive themselves to be competitively advantaged relative to others, conferring greater relative state, which in turn increases the probability of success and the expected value of aggressive behavior. For example, someone who is large and strong may regularly be involved in physical altercations because they are likely to win such altercations, and likely to gain desirable outcomes from such behaviors (i.e., access to proxies of fitness, including mating opportunities, resources, status, and reputation; for example, Sell et al., 2009). These predictions may also extend to social collectives (from groups to nation-states); countries with larger armies, for example, may be more likely to initiate conflict because they are more likely to win such conflicts.

Mating

Romance is full of risk: Hazards include unrequited love, loss of reputation, desertion, sexual aggression, partner infidelity, being caught unfaithful oneself, and so on; upsides include proximate bliss and the ultimate functional reward of reproduction. Each romantic action carries its own payoffs and probabilities of success, each of which can differ between people and between environments. For example, attractive people are more likely to succeed when pursuing any given partner (e.g., Gangestad & Simpson, 2000) and perhaps more likely to be forgiven if their attempt at an illicit affair gets discovered (e.g., Phillips & Hranek, 2012; Waynforth, 2001) than are unattractive people. People who are currently in partnerships have more to lose from failed risks than single people (Daly & Wilson, 1998, 2001). An attractive partner represents a higher payoff (in fitness terms) if successfully courted, and so is worth taking risks to attract (as long as one has a reasonable chance of success). People with few future romantic prospects should engage in more desperate mating attempts than people who think there are "many other fish in the sea" (e.g., Nunes & Pettersen, 2011). As one example, risky courtship strategies may increase toward the end of a pub night among those who remain unpaired. This prediction is consistent with evidence suggesting that at closing time, unpaired bar patrons (i.e., those not in a relationship) rate people of the opposite sex as more attractive (Madey et al., 1996; Pennebaker et al., 1979). Men and women face different costs for failed risks, including differential costs of being rejected (Haselton & Buss, 2000), being labeled as promiscuous or unfaithful (Buss & Dedden, 1990), or being subject to sexual aggression (Lalumière et al., 2005).

These differential costs, benefits, and probabilities of success should all factor into people's unconscious calculations of whether to pursue any mating-related behavior. In romantic competition, relative state is crucial: It does not matter how attractive, smart, wealthy, or funny you are, it depends on how much *more* attractive, smarter, wealthier, funnier you are than your competitors. Thus, all of the above should be affected not just by one's absolute level on any of those traits but one's level relative to others in the environment.

Conclusion

In this article, we argue that the relative state model—a framework integrating interrelated need-based and ability-based pathways to risk-taking—can account for different observed patterns of risk-taking behavior. The model can explain why risk-taking sometimes appears to be domain-specific and why it sometimes appears to be domain-general. The model can also account for when people will engage in antisocial versus non-antisocial forms of risk-taking. Importantly, the model offers functional explication of key situational/environmental and embodied influences on risk-taking behavior.

Throughout the article, we have provided examples suggesting that the relative state model can be successfully applied to understanding such wide-ranging and diverse behaviors as sports strategy, finance and trading, conflict and cooperation, interpersonal violence, mating, and even state-level violence. Because our model is relevant to understanding decision-making in any context(s) that involve some consideration of an actor's relative position, it has extremely wide explanatory scope. We very much look forward to future empirical research examining the explanatory bounds (and constraints) of our model. We are hopeful that the relative state model can help reconcile long-standing theoretical and empirical disagreements on the etiology of risk-taking behavior in an integrative manner.

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