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Angry men and disgusted women: An evolutionary approach to the influence of emotions on risk taking☆

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Abstract

Despite considerable research on the influence of emotions on risk taking, investigators have yet to agree on an explanatory framework. Reviewing the literature, we identify problems with popular valence-based approaches. In contrast, Lerner and Keltner's (2000, 2001) appraisal-tendencies theory has been supported, and usefully generates testable predictions regarding the effects of specific emotions. Nevertheless, though premised on the assumption that functional attributes differentiate emotions, this theory overlooks the ultimate goals that emotions serve. Adopting an evolutionary perspective, we predicted that, despite having similar appraisal tendencies, anger and disgust would have opposite effects on risk taking, since anger functions to deter transgression through aggression, while disgust functions to ward off contamination; an evolutionary perspective also led us to predict sex differences in these effects. Employing a gambling task involving substantial real stakes, we demonstrate that anger increases risk taking in men, while disgust decreases risk taking in women.
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Over the last decade, scholars have focused increasing attention on the role of emotions in decision making (Bosman & van Winden, 2001; Charland, 1998; Damasio, 1994; Elster, 1998; Loewenstein & Lerner, 2002; Loewenstein, Weber, Hsee, & Welch, 2001; Pillutla & Murnighan, 1996; Schwarz, 2000). A particularly important issue in this regard is the impact of emotions on decisions involving risk (defined here as the potential for negative outcomes), as this category includes many behaviors that have significant personal and social consequences. To date, investigators have sought to explain the influence of emotions on risk taking largely in terms of the effects of attributes, or combinations of attributes, that differentiate emotions from one another at the proximate or descriptive level. In contrast to such an approach, we adopt an evolutionary view, arguing that the impact of emotions on risk taking is best explored in terms of the ultimate functions that specified emotions evolved to perform. After reviewing the literature, we demonstrate that an evolutionary functionalist approach accurately predicts differing effects on risk taking of two emotions, anger and disgust, differences that are not explicable in terms of the proximate dimensions emphasized by previous researchers. The same focus on ultimate functions also sheds light on sex differences, an issue hitherto largely overlooked in the literature on emotion and risk taking.

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Review of research to date

Emotions impact decision making in at least two ways. First, previously experienced emotions may influence the attractiveness of a variety of potential future courses of action, often via the anticipation of the effects of various outcomes on one's emotional state (Elster, 1998; Loewenstein et al., 2001; Mellers & McGraw, 2001; Mellers, Schwartz, & Ritov, 1999). While not unimportant, this aspect of emotions is of lesser interest to us, as, in these cases, emotions play a passive role in the decision making process, being simply one of many sources of an individual's preferences. In contrast, in a second class of situations, emotions play an active role in the decision making process. Specifically, the ongoing experience of an emotion may differentially highlight various options for responding to the eliciting event. Since many of the most dramatic (and often puzzling) decisions involving risk seem to be influenced by active rather than anticipated emotions, it is with this class of events that we concern ourselves here.

The majority of contemporary theories regarding the relationship between active emotions and risk taking either derive from, or are reactions to, one of two seminal approaches to the problem, namely Isen and colleagues' mood maintenance hypothesis, and Johnson and Tversky's (1983) affective generalization hypothesis.

As initially formulated by Isen and Patrick (1983), the mood maintenance hypothesis held that people in a positive mood avoid taking risks in order to maximize the likelihood that their positive mood will be maintained. This view was subsequently amended to include the proposal that those in a negative mood seek out risks in an attempt to achieve gains that will produce a positive mood (for contributions to the mood maintenance tradition, see Arkes, Herren, & Isen, 1988; Isen & Geva, 1987; Isen, Nygren, & Ashby, 1988; Mano, 1992; Nygren, Isen, Taylor, & Dulin, 1996). Although important findings have been contributed by investigators adopting this perspective, the approach nevertheless suffers from a number of limitations. First, advocates have interpreted mutually contradictory results as lending support to the proposition that people seek to maintain good moods and truncate bad ones (see esp. Arkes et al., 1988; Mano, 1992; Nygren et al., 1996). More broadly, the phenomenology of some negative emotions appears not to be consistent with the hypothesis (Hockey, Maule, Clough, & Bdzola, 2000). For example, angry people may ruminate on the eliciting event (Rusting & Nolen-Hoeksema, 1998) or seek out the antagonist (reviewed in Kring, 2000), behaviors that likely prolong rather than shorten this negative affect. Consistent with this observation, as will be discussed at length, recent investigations indicate that emotions and moods do not have a uniform effect on risk taking as a function of valence.

Whereas the mood maintenance hypothesis seeks to explain the overarching effects of emotions on risk taking, Johnson and Tversky's (1983) affective generalization hypothesis focuses on subjective probabilities, a component of decision making. Johnson and Tversky claim that exposure to information that elicits negative affect increases the perceived frequency of events which, though unrelated, have the same affective valence. Unlike the mood maintenance hypothesis, the affective generalization hypothesis does not view the impact of emotions on decision making as goal-directed, but rather presents the observed effect as an accidental consequence of the operation of the emotion system.

DeSteno, Petty, Wegener, and Rucker (2000) question both Johnson and Tversky's focus on valence and their afunctionalism. The authors argue that emotions inform individuals about the current state of the environment in which they find themselves. Because the occurrence of an event of a given type is crudely predictive of the occurrence of other events of the same type, and because emotions mark such categories, DeSteno et al. predict that, rather than being a function of valence, the impact of emotions on frequency estimation should be emotion-specific. Presenting news accounts that elicited either anger or sadness prior to a frequency-estimation task, the authors demonstrate that, although both primes elicited negative affect, each prime influenced frequency estimates only for events associated with the given emotion. Inducing happiness, sadness, or anger using a relived emotion task, DeSteno et al. then demonstrate that, for participants low in need-for-cognition, even an obviously arbitrarily induced emotional state biases frequency estimates for events associated with the given emotion (see also Wright & Bower, 1992).

Adopting a different tactic in the attack on the primacy of valence in decision making, Lerner and Keltner (2000, 2001) argue that emotions are differentiated from one another not with regard to valence, but on the basis of differences in their impact on various cognitive appraisals—it is the latter, the authors assert, which shape the willingness to take risks. Drawing on Smith and Ellsworth (1985), Lerner and Keltner (2000) argue that anger is associated with high certainty, medium anticipated effort, high control, and high responsibility. In contrast, fear is associated with low certainty, high anticipated effort, low control, and medium responsibility. Broadly, anger thus produces a tendency to perceive negative events as predictable, under human control, and brought about by others, while fear produces a tendency to perceive negative events as unpredictable and under situational control. Using both trait and state measures, the authors assessed fear and anger, then employed Johnson and Tversky's frequency-estimation task. Consistent with the claim that appraisal tendencies determine the impact of emotions, although both anger

and fear are negatively valenced, angry people made optimistic judgements about the likelihood of adverse events, while the opposite was true of fearful people.

Extending their method to decision making, Lerner and Keltner (2001) measured trait anger and fear, then gave participants Tversky and Kahneman's (1981) Asian Disease Problem, in which subjects must choose how best to save members of the public from a fatal illness. Consistent with the differences in appraisal tendencies between the two negatively valenced emotions, angry people made risk-seeking choices, while fearful people made risk-averse choices. Returning to subjective probabilities, adding a measure of trait happiness, the authors asked participants to estimate their chances of experiencing various life events. Again in contrast to valence-based predictions, both trait anger and trait happiness correlated positively with optimistic risk estimates, while trait fear had the opposite effect, with the anger/fear difference deriving from assessments of the probability of events that were seen as ambiguous with regard to their relative controllability. Finally, Lerner and Keltner used a relived emotion task to induce anger, fear, and happiness, assessed the degree of control and certainty that participants experienced in regard to the events described, and administered another life events questionnaire. Results indicate that differences between the effects of anger and fear on probability estimates were mediated by differences in the perceived control associated with each class of elicitors.

Building on Lerner and Keltner's approach, Lerner, Gonzalez, Small, and Fischhoff (2003) focused participants' attention on feelings of either anger or fear in regard to the 9/11 terrorist attacks, then collected likelihood estimates regarding future events. Anger led to lower risk estimates, while fear had the opposite effect. Men's estimates were more optimistic than women's, a pattern largely, but not wholly, accounted for by differences in the levels of anger and fear reported (no explanation is offered for either the sex difference in emotional response or the residual sex difference in risk estimates). Consistent with the appraisal tendencies hypothesis, the authors interpret their results in terms of differences in control and certainty associated with anger and fear.

Together with the work of others (e.g., Leith & Baumeister, 1996; Raghunathan & Pham, 1999), the investigations of DeSteno et al. and Lerner, Keltner, and colleagues demonstrate that the effects of emotions on risk taking are unlikely to be principally explicable as a function of valence. While these investigations cast doubt on the premise on which both the mood maintenance hypothesis and the affective generalization hypothesis are based, for both methodological and theoretical reasons, the corpus of recent work leaves a number of questions outstanding regarding the impact of emotions on risk taking.

Much work to date has focused on subjective probabilities. While estimations of the likelihood of various outcomes can impact decision making, this is not the only avenue whereby emotions may influence risk taking. Ethnographic accounts of real-world risk taking (e.g., Katz, 1999, pp. 18–83) suggest that emotions also shape both the subjective utility of various outcomes and the salience of those outcomes independent of their subjective probabilities. Hence, because subjective probabilities likely only incompletely determine actual choices, focusing on subjective probabilities may lead investigators to overlook some potentially important features of the relationship between emotions and risk taking behavior.

Though developed in regard to the question of subjective probabilities, DeSteno et al.'s event categorization perspective could conceivably be extended to address actual decision making. However, published results raise questions regarding the predictive power of such an extension. For example, failing to obtain money in a gamble might reasonably be expected to elicit sadness (among other emotions). The event categorization perspective therefore suggests that induced sadness should enhance the perceived likelihood of gambling failures, and hence, by extension, that sadness induction should decrease the preference for risky choices in gambling tasks. However, experiments reveal that sadness induction has either no effect (Leith & Baumeister, 1996) or a positive impact (Raghunathan & Pham, 1999) on the preference for risky options in gambling tasks. This example suggests that, presumably as a consequence of the multiple avenues whereby emotions impact decision making, there may be limits on the extent to which DeSteno et al.'s event categorization approach sheds light on actual risk taking behavior.

Although most of their work has focused on subjective probabilities, Lerner and Keltner's appraisal tendencies hypothesis is not limited to this aspect of decision making. Nevertheless, consideration of the theoretical underpinnings of the appraisal tendencies perspective provides principled reasons why this approach may at times fail to predict the impact of emotions on actual risk taking. Though the authors do not develop the underlying rationale at length, Lerner and Keltner's approach is based on the insight that each emotion constitutes an adaptive response to a class of events sharing a single core meaning (Frijda, 1986; Lazarus, 1991). However, foregrounding appraisal tendencies makes it easy to overlook the ultimate functions of the emotions at issue. We concur that emotions influence appraisals in order to shape behavior toward specific functional outcomes. However, we suggest that, because the same appraisal tendencies can serve different overarching goals, focusing on appraisals rather than goals can erroneously predict similar effects on decision making across very different emotions. Adopting a more explicitly

evolutionary perspective, we seek to illustrate the explanatory power of attending directly to the ultimate functions of the emotions at issue.

An evolutionary approach to the impacts of anger and disgust on risk taking

Considerable advances have recently been made in formulating and employing evolutionary approaches to the emotions (cf. Cosmides & Tooby, 2000; Edwards, 1999; Frank, 1988; Frijda, 1994; Johnston, 1999; Nesse, 1990; Öehman & Mineka, 2001; Weisfeld, 1997). Evolutionary perspectives share the premise on which Lerner and Keltner's appraisal tendencies theory is based, namely that emotions constitute specialized responses to thematically unified classes of events. However, rather than simply taking this as a starting point, an evolutionary psychology of emotions explicitly focuses the theoretical lens on this issue. In so doing, this perspective diverges from other versions of functionalism. All functionalist theories are based on some metric whereby the utility of various outcomes can be assessed. Evolutionary approaches to the emotions differ from other forms of functionalism in that the metric at issue is neither subjective well-being, social harmony, nor success in contemporary society. Rather, viewed from an evolutionary perspective, our capacity and propensity to experience emotions exist because emotions shape behaviors in ways that would have enhanced biological fitness in the social and physical environments that humans occupied for most of our species' history. A central research tactic in the evolutionary psychology of the emotions is thus to: (1) determine the class of events that elicit a given emotion; (2) identify the manner in which, under ancestral conditions, such events would have impacted biological fitness; and (3) examine how the given emotion's effects on behavior would have often maximized fitness in response to those events. Note that, because the modern world differs profoundly from ancestral environments, there is no presumption that emotions currently enhance biological fitness—just as today our evolved preferences for fat and sugar lead to health problems despite having functioned effectively in an environment of caloric scarcity, so too may our emotions now often lead to fitness-reducing, rather than fitness-enhancing, outcomes.

The approach outlined above is congruent with the empirical findings summarized earlier: from an evolutionary perspective, it is unlikely that emotions sharing the same valence would necessarily have the same effect on risk taking, since valence is not uniformly associated with different classes of adaptive functional goals. For example, the differing impacts of fear and anger documented by Lerner and Keltner (2000, 2001) and Lerner et al. (2003) are consistent with the premise that each of these emotions addresses a different adaptive problem. Fear, the response to imminent threat, motivates escape and the search for safety (Frijda, 1986; Lazarus, 1991; Levenson, 1999; Öehman & Mineka, 2001). Anger, the response to transgression, motivates aggression that truncates ongoing transgressions and/or deters future transgressions (Edwards, 1999, pp. 140–141; Frank, 1988; Frijda, 1986; Lazarus, 1991; Levenson, 1999; McGuire & Troisi, 1990). It is thus expectable that fear and anger will have opposite effects on the propensity to take risks, as the functional objective of fear centers on minimizing the potential for harm to oneself, while the functional objective of anger entails increasing the immediate risks to which one is exposed.

An evolutionary approach to emotions predicts differing impacts of fear and anger on risk taking without taking account of their respective appraisal tendencies. However, because the resulting prediction is identical to that generated by Lerner and Keltner's perspective, the fear-versus-anger contrast does not allow us to determine which approach more accurately predicts the impact of emotions on risk taking. Consider, therefore, another negative emotion, disgust. Viewed from an evolutionary perspective, disgust, the response to the presence of contamination, motivates avoidance of contact in order to reduce exposure to pathogens and toxins (Cosmides & Tooby, 2000; Curtis & Biran, 2001; Curtis, Aunger, & Rabie, 2004; Fessler & Navarrete, 2003; Levenson, 1999; Wronska, 1990). An evolutionary functionalist perspective thus predicts that disgust will decrease risk taking behavior. Smith and Ellsworth (1985, pp. 827–829, 833), Lerner and Keltner's primary source for the cognitive attributes associated with emotions, describe disgust as characterized by a similar amount of certainty and control compared to anger. Indeed, in the mapping of situational control-vs.-human control and self-vs.-other responsibility, of the 15 emotions evaluated, disgust is the most similar to anger. Lerner and Keltner's appraisal-tendency perspective therefore predicts that disgust will operate in a similar fashion to anger, i.e., it will increase risk taking behavior. Hence, because the evolutionary functionalist perspective and the appraisal-tendency view generate opposite predictions with regard to the effects of disgust on risk taking, this emotion constitutes an ideal focus for a test intended to differentiate between the two approaches.

To examine the predictive power of an evolutionary functionalist perspective relative to an appraisal-tendency view, we set out to investigate the influence of disgust on risk taking behavior. Anger, another negatively valenced emotion, has figured prominently in previous investigations, and, consistent with conclusions therein, naturalistic data strongly suggest that anger has a particularly significant positive (i.e., exacerbating) impact on risk taking (Daly & Wilson, 1988; Kring, 2000).

Anger is therefore an attractive point of comparison for disgust.

Predicted sex differences in the effects of anger and disgust

To date, although a substantial corpus of research examines sex differences in risk taking (Byrnes, Miller, & Schafer, 1999; see also Eckel & Grossman, 2002), investigators interested in the effects of emotions on such behavior have largely overlooked this topic, presumably because it is extraneous to the assumptions on which existing theories are premised. In contrast, due to fundamental differences in the adaptive challenges that confronted men and women in the evolutionary past, sex differences play a central role in evolutionary approaches to risk taking (Eckel & Grossman, 2002; Fetchenhauer & Rohde, 2002; Wilson & Daly, 1985).

All human populations exhibit sexual dimorphism in which mean male height and strength exceed those of females (Holden & Mace, 1999). Cross-species comparisons indicate that such dimorphism is explicable in terms of differences between the sexes in the variance in reproductive success among members of the same sex (Alexander, Hoogland, Howard, Noonan, & Sherman, 1979; Plavcan & Van Schaik, 1997). Briefly, because relative differences in reproductive success lie at the heart of the processes of natural selection that shape organisms, in any species, the prevailing level of social competition is expected to be a function of the variance in reproductive success. If there is little variance in this regard, social competition can be construed as a low-stakes game since, from the perspective of natural selection, the disparity between winners and losers is small. Conversely, if there is high variance in reproductive success, social competition constitutes a high-stakes game, one in which winners produce many progeny and losers produce few or none. Sexual dimorphism in size and strength occurs when greater variance in reproductive success in one sex (typically males) favors the evolution of enhanced fighting abilities, as the costs of armaments and the risks of combat are outweighed by the gains to be reaped by excluding reproductive competitors (reviewed in Plavcan & Van Schaik, 1997).

Because competitive armaments are of little use without correspondingly aggressive behavioral inclinations, natural selection shapes behavior as well as morphology. Accordingly, consistent with the logic of a high-stakes game, in a sexually dimorphic species, the larger sex can be expected to be both more willing to transgress against competitors and more willing to risk incurring high costs in order to deter transgressions. In our species, this panmammalian pattern is amplified by a number of uniquely human attributes. First, because language allows for the establishment of reputations, the ramifications of a given transgression are not limited to the actors present at the time of the event. Failure to respond aggressively to a transgression can lead to a reputation as an 'easy mark,' inviting additional transgressions by a large number of rivals. Conversely, disproportionately aggressive reactions to transgression can establish a reputation as a dangerous 'hothead,' effectively deterring many who might otherwise contemplate transgressing against the actor (Frank, 1988; Daly & Wilson, 1988). Second, our species is unique among primates in combining male–male sociality with high paternal investment in offspring. In other primate species, if the male greatly assists the female in rearing offspring, few or no other males occupy the same territory; conversely, if many males live in a single group, males do very little to assist in rearing offspring (see reviews in Smuts, Cheney, Seyfarth, & Struhsaker, 1987). Male investment in rearing creates an opportunity for exploitation, since cuckolded males may unknowingly waste their investment on other males' progeny. Presumably, in ancestral hominids, the benefits of male-male cooperation favored sociality despite the costs of living in proximity to potential lotharios. Nevertheless, the presence of other males will have intensified the selective pressure for a male propensity to guard females' reproductive capacities. Consistent with this logic, around the world, adultery is defined as a transgression against a cuckolded man (Wilson & Daly, 1992); correspondingly, human males exhibit a proprietary attitude toward women in whom they invest (Wilson & Daly, 1992), and are prone to sexual jealousy (Buss, Larsen, Westen, & Semmelroth, 1992), an emotion with a strong anger component (Mullen & Martin, 1994). Angry, jealous men frequently physically assault their rivals, often with the explicit goal of seeking retribution and deterring future transgressions (Felson, 1997). Finally, reputation effects and the costs of cuckoldry compound one another, as rivals may be more likely to attempt to seduce the wife of a man who has a reputation for failing to respond aggressively to transgressions.

As a consequence of the factors discussed above, in ancestral populations, men stood to reap significant fitness benefits from a demonstrable willingness to risk incurring substantial costs in order to inflict costs on transgressors (Daly & Wilson, 1988; Wilson & Daly, 1985). In contrast, although ancestral women were not immune to fitness decrements due to transgressions, for several reasons, females should have been only willing to incur lower costs in reacting to transgressions. First, consistent with the logic of a low-stakes game, for women, it would generally not have been worth jeopardizing one's survival or that of one's dependent offspring in order to gain a relatively small advantage over female rivals. Second, because women could obtain both provisioning and protection from men, women would often not have benefited by placing themselves in danger in order to defend against transgression—far

better to appeal to risk-prone males to either replace the stolen goods, attack the transgressors, or both.

Together, the factors discussed above lead to the conclusion that natural selection can be expected to have favored a greater willingness among men to incur costs in reacting to transgression. Anger is a central part of the proximate mechanism shaping the behavioral response to transgression, hence anger can be expected to have led to greater risk taking in men than in women. Because, on an evolutionary time scale, our rise from a hunter–gatherer lifestyle has occurred in the blink of an eye, this difference should persist to the present day even though human reproduction is now largely divorced from the factors that governed it for most of our species' history. This perspective is consistent with: (a) the vastly greater representation of men in violent conflicts that begin as trivial altercations (Daly & Wilson, 1990; Ghiglieri, 1999), and (b) the finding that men are more likely to confront the target of their anger, particularly when it is a stranger, while women are more likely to turn to others for support (reviewed in Kring, 2000) or to seek to damage the transgressor's social standing through gossip, alliance manipulation, or other indirect means (reviewed in Campbell, 2002, pp. 90–94).

While similarly arguing that natural selection has favored greater avoidance of physical harm among females, Campbell (2002, pp. 74–100) develops an alternative to the proposal outlined above. Citing Brody, Lovas, and Hay's (1995) finding that anger-eliciting situations evoke more fear in women than in men (and consistent with Lerner et al.'s, 2003 results), Campbell proposes that, although transgressions stimulate equivalently risk-promoting anger among men and women, the latter's greater fear response inhibits them from taking risks.

Just as the costs and benefits of reacting aggressively to transgression likely differed across the sexes in ancestral populations, so too did men and women likely differ with regard to the costs and benefits of avoiding contamination. Because reproductive success is the nexus of natural selection, the more directly, and the more strongly, that any trait affects reproduction, the greater the selective pressures shaping that trait. A woman's reproductive success is contingent on her ability to carry each pregnancy to term. Because the process of organogenesis is highly vulnerable to perturbation, pathogens, and parasites can significantly disrupt embryonic and fetal development. Yet, at precisely this crucial time in a woman's life, her ability to ward off infections is severely compromised. The immune system guards the body by detecting and attacking foreign material. Because half of the embryo's genes come from the father, if left to its own devices, the maternal immune system would destroy the embryo. Pregnancy is therefore accompanied by a suppression of the maternal immune system, creating unavoidable vulnerability to infection (reviewed in Fessler, 2002). Behavioral prophylaxis offers a means of mitigating the costs of this gestational immunosuppression. Moreover, because immunosuppression also occurs in anticipation of pregnancy, the window of vulnerability is not limited to gestation, but also occurs on a cyclic basis in nonpregnant women of reproductive age (reviewed in Fessler, 2001b), a pattern favoring extension of behavioral prophylaxis outside of the period of gestation. Reproductive immunosuppression may thus have generated selective pressure leading to enhanced caution in women when confronted by potential sources of infection.

The selective pressure favoring female caution in the presence of contaminants will have been augmented by human patterns of caretaking behavior. As a result of both the sex difference in the ability to lactate and a pervasive gender-based division of labor, in traditional small-scale societies, infants and small children are cared for primarily by their mothers and other female kin. Human offspring, being highly altricial, are extremely vulnerable to disease throughout this period. Patterns of caretaking likely thus increased the importance of contaminant avoidance, as human females in ancestral populations who failed in this regard would have risked sickening their infants or younger siblings (Curtis et al., 2004).

In marked contrast to the female case, males in ancestral populations may have benefited from demonstrable indifference to the risk of contamination. As in many other species in which the variance in reproductive success differs across the sexes, reproductive access to sexually mature females is a principal determinant of human male reproductive success. While aggressive male-male competition is one factor influencing such access, female choice is equally, if not more, important. Among the criteria employed by women in selecting a mate, physical and behavioral attributes indicative of genetic quality loom large, particularly when selecting a short-term partner.

Male secondary sex characteristics (in humans, these include prominent brow ridges, a deep voice, and facial hair) all advertise the presence of high levels of androgens. Because these hormones have immunosuppressive effects, males who display marked secondary sex characteristics while remaining healthy signal to prospective mates that they possess the genes for a robust ability to combat pathogens, a feature of great value in a mate (Folstad & Karter, 1992; see Rhodes, Chan, Zebrowitz, & Simmons, 2003 for review). A male's willingness to approach sources of contamination can be viewed as a behavioral analog of such morphological signals, a claim regarding the individual's immunological robusticity—just as bright plumage or a large rack of antlers communicates to nonhuman females that a male is able to afford the costs of androgen-induced immunosuppression, so too does indifference to the presence of

contaminants by a highly masculine man send the message to women that the individual carries the genes for a very effective immune system. Hence, in ancestral human populations, natural selection would have favored males who exercised the absolute minimum affordable level of disease avoidance, operationalized as a muted increase in caution during the experience of disgust—any excess of caution in the presence of contaminants would have signaled poor genetic quality, and hence would have decreased a man's ability to attract mates.

The communicative value for males of a lack of caution in the presence of contaminants may also extend beyond the question of heritable differences in immunological robusticity. Because a willingness to take risks with one's physical welfare in one domain is often crudely predictive of equivalent behavior in other domains, following the logic delineated above for anger, minimizing caution in response to disgust elicitors can signal to both prospective mates and rivals that, because the man is indifferent to potential harm, he is a formidable protector and adversary, respectively. Support for this possibility comes from the existence of male competitive displays of indifference to disgust stimuli (e.g., goldfish swallowing contests among fraternity members in American universities). In sum, observations regarding the costs of female reproductive immunosuppression and the benefits of male signaling lead to the same prediction, namely that disgust, the response to contaminants, will decrease risk taking more in women than in men.

Methodological considerations

In addition to predicting sex differences in the impact of anger and disgust on risk taking, the evolutionary rationales laid out above can also be read as predicting sex differences in the ease and intensity with which these emotions are elicited, as behavioral sex differences might be produced via: (a) differences in the operation of the respective emotions across the sexes, (b) differences in the response thresholds for the respective emotions across the sexes (Loewenstein et al., 2001), or (c) both. While considerable research suggests that the frequency and intensity with which anger is experienced does not differ across the sexes (reviewed in Kring, 2000; see also Milovchevich, Howells, Drew, & Day, 2001), additional work indicates that women are more easily and more intensely disgusted than men (Haidt, McCauley, & Rozin, 1994; Quigley, Sherman, & Sherman, 1997). In addition, there is evidence that the sexes differ with regard to the kinds of events most likely to elicit anger (reviewed in Kring, 2000; see also Buss, 1989). Because we are interested here in investigating the possibility that anger and disgust are operationally sexually dimorphic with regard to their impact on risk taking, it is important to select a method that is likely to elicit equivalent levels of the target emotions in men and women. Relived emotion tasks are therefore useful, as endogenous stimulation may circumvent the problems raised by sex differences in both disgust sensitivity and the evocative power of some anger elicitors.

Because individuals likely differ with regard to a variety of attributes that might impact performance on our measure of risk taking, thereby introducing noise into the results, we sought to measure self-reported risk taking behavior in a number of domains.

With the above considerations in mind, we conducted a study composed of three elements: (1) a questionnaire asking participants to report their level of participation in a wide variety of risk taking activities, (2) a relived emotion exercise, and (3) a decision making task in which participants repeatedly chose between a substantial guaranteed payoff and a chance at a larger sum.

Methods

Participants

Participants were recruited using flyers posted on the UCLA campus and announcements in large undergraduate classes at UCLA. Participants were UCLA undergraduate students and staff. Participation was anonymous and voluntary. Participants received $5.00 for participation in addition to any moneys obtained in the Choice Task (see below).

For reasons of expediency, the study discussed here was conducted concurrently with two other investigations; participants were randomly assigned to one of six conditions, anger, disgust, control, or three conditions not relevant to the present discussion. Twenty men and 20 women were assigned to each condition. One man failed to complete participation in the disgust condition, resulting in a sample of 59 men and 60 women (mean age = 21 years, $SD = 2.4$, range = 18–34) distributed across the three conditions with which we are here concerned.

Procedure

Participants first completed a questionnaire composed of 27 items intended to measure the frequency with which they engaged in risky behaviors in the following domains: physical risk (e.g., "In your lifetime, how many times have you broken bones as a consequence of your own actions?"), social risk (e.g., "In the past year, have you publicly stood up for an unpopular belief/opinion in the face of general disagreement?"), and sexual risk (e.g., "In the last year, how many sexual partners have you had?").

Following completion of the behavior inventory, a research assistant read a script (see Appendix A) containing instructions for both the Choice Task (see below) and an emotion induction procedure, described as a "visualization task." Instructions for the Choice Task were presented prior to emotion induction in order to reduce the delay between induction and the measure of risk taking. Because norms for the expression of anger and disgust likely differ by gender (Fischer & Manstead, 2000; Kring, 2000; Kring & Gordon, 1998; Milovchevich et al., 2001), every effort was made to minimize impression management effects: the participant was left alone in a room to complete the task, was reminded in writing that the task was anonymous, and was told to seal the materials in an envelope upon completion of the task, with the assurance that the envelope would remain sealed until the entire project was finished. Written instructions, read in private, asked participants to recall or imagine a time when they had experienced the target emotion, then write a brief essay about that time. For example, in the anger condition, participants were instructed: "(a) Imagine that someone has done something to make you really angry. Briefly describe the circumstances that would make you the most angry. (b) Jot down, as specifically as you can, your feelings and emotions in response to the angry situation you just described." Participants in the control condition were instructed to describe the experience of watching television.

Immediately following the emotion induction task, in the same private room where emotion induction had occurred, a research assistant orally administered the Choice Task (adapted from Henrich & McElreath, 2002) (see Appendix B). Participants were asked to make a series of four choices in four independent rounds of play; each choice consisted of a sure payoff option of $15.00 and a chance option to obtain a greater sum of money at a known probability. The expected value of all options was $15.00; chance options were as follows: $18.75 at an 80% chance, $37.50 at a 40% chance, $75.00 at a 20% chance, and $300.00 at a 5% chance. Half of the participants received the rounds of play in order of decreasing probability (i.e., the 80% chance first and the 5% chance last) and half the participants received the rounds of play in the opposite order. Because performance is generally better when reasoning about frequencies than when reasoning about probabilities (Gigerenzer & Hoffrage, 1995), for each risky option, the odds were expressed both as a frequency (X out of 20) and as a probability. Participants had been instructed to make their choice in each round independently of all other rounds, and had been told that, once they had made all four choices, one of the rounds would be chosen at random using a spinner, and they would be paid according to their choice in that round, with chance options being operationalized via the drawing of colored marbles from a bag. The task was administered orally in order to make it more difficult for participants to review prior choices in making a given choice.

As a manipulation check, after participants had made each of their four choices, but before one round was selected to be carried out, participants completed the PANAS-X state affect scale (Watson & Clark, 1994) in order to assess the extent to which the target emotion was active at the time that the choices were made. A round was then selected, the choice was carried out, payment was provided, and the participant was thanked and escorted to the hall. Care was taken to avoid contact between participants leaving the lab and those waiting to participate so as to reduce the likelihood that comments or affective displays by departing individuals would influence subsequent participants' behavior.

Results

Risk taking

Because our predictions concerned the effects of emotions on the general tendency to take risks rather than on the differential attractiveness of any particular risky option relative to other such options, we elected to assess risk taking by counting the number of times that a participant selected the chance option on the Choice Task. Selecting the sure payoff option in a given round was designated with a risk score of 0, while selecting the chance option in a given round was designated with a risk score of 1. Summing these scores over the four rounds produced total risk scores ranging from 0 (i.e., the participant selected the sure payoff option in all four rounds) to 4 (i.e., the participant selected the chance option in all four rounds). Because this scale exhibited only modest internal consistency ($\alpha = .38$), we tested for differential effects of different levels of risk (e.g., a 20% gamble for a slight increase in payment, a 5% gamble for a large payoff, etc.) using regression analyses to explore possible interactions between specific risk levels, sex, and emotion induction conditions. None of the interactions with individual levels of risk were significant, indicating that, within condition and within sex, participants were not treating different levels of risk significantly differently from one another, and hence our decision to sum the number of risky choices across the four rounds did not inherently bias the test in favor of the predicted pattern of results.

Regression analyses

All analyses were performed using the total risk score described above as the dependent measure. Tests of predictions are two-tailed unless otherwise noted.

Risky behavior inventory

A factor analytic examination of responses across conditions to the 27 questions in the risky behavior inventory revealed that 20 of these parsed neatly into three internally consistent subscales corresponding with the three domains of risk taking we had sought to measure: sexual risk taking (four items, $\alpha = .55$), physical risk taking (11 items, $\alpha = .67$), and social risk taking (five items, $\alpha = .66$). Because responses on these subscales were largely correlated with one another (physical risk with social risk: $r = .24$, $p < .01$; physical risk with sexual risk: $r = .23$, $p < .05$; sexual risk with social risk: $r = .08$, ns) we constructed a single highly consistent risky behavior scale composed of all 20 items ($\alpha = .72$).

Across the sample as a whole, men reported far greater rates of risky behavior than did women ($F(1,117) = 16.52$, $p < .001$), a pattern driven by greater physical risk taking ($F(1,117) = 9.27$, $p < .01$), and greater social risk taking ($F(1,117) = 6.91$, $p < .01$); no sex difference was reported in sexual risk taking ($F(1,117) = 1.77$, $p = .19$).

Scores on the composite risky behavior scale were significantly correlated with performance in the Choice Task ($r = .27$, $p < .01$), and the same was true of scores on the social risk taking subscale ($r = .18$, $p = .05$) and the sexual risk taking subscale ($r = .22$, $p < .05$); scores on the physical risk taking subscale were only marginally correlated with responses on the Choice Task ($r = .16$, $p = .08$).

Emotion induction

To assess the effectiveness of the emotion induction task, we used two separate manipulation checks. The first was participants' self-report of their affective state following the emotion induction task as recorded using the PANAS-X (Watson & Clark, 1994). Participants in the anger condition reported experiencing significantly more anger ($B = 1.58$, $SE = .25$, $t = 6.32$, $p < .001$) and disgust ($B = 1.23$, $SE = .22$, $t = 5.61$, $p < .001$) than did participants in the control condition. There was no interaction of emotion induction condition with sex of participant on self-reported emotional intensity for either anger ($B = .35$, $SE = .50$, $t = 0.70$, $p = .48$) or disgust ($B = .05$, $SE = .44$, $t = 0.11$, $p = .91$). In light of Campbell's (2002) hypothesis that sex differences in risk taking in response to transgression are caused by greater female fear during anger-eliciting events, we also examined the level of self-reported fear, finding no effect of emotion induction condition on self-reported fear ($B = .21$, $SE = .15$, $t = 1.44$, $p = .15$) and no interaction of emotion induction condition and sex on fear ($B = -.24$, $SE = .29$, $t = -0.83$, $p = .41$). In this condition, there was also no main effect of sex on self-reported fear ($B = -.16$, $SE = .15$, $t = -1.12$, $p = .27$).

In the disgust condition, participants reported experiencing significantly more disgust ($B = 2.51$, $SE = .21$, $t = 12.01$, $p < .001$) and significantly more anger ($B = 1.25$, $SE = .24$, $t = 5.02$, $p < .001$) than participants in the control condition. There was no interaction with sex on levels of self-reported anger ($B = -.31$, $SE = .49$, $t = -0.63$, $p = .27$), but there was a significant interaction of emotion induction condition and sex on self-reported feelings of disgust ($B = -1.21$, $SE = .42$, $t = -2.90$, $p < .01$), as women reported feeling less disgust than men. There was also no main effect of emotion induction condition on self-reported levels of fear ($B = .25$, $SE = .15$, $t = 1.62$, $p = .11$), nor was there a significant interaction of sex and emotion induction condition ($B = -.50$, $SE = .30$, $t = -1.67$, $p = .10$). There was, however, a marginally significant main effect of sex on self-reported levels of fear ($B = -.29$, $SE = .15$, $t = -1.95$, $p = .06$), as men reported feeling more fear than did women. Men reported significantly more fear in the disgust condition than in the neutral condition ($B = .50$, $SE = .21$, $t = 2.33$, $p < .05$); a pattern that was not present among women ($B = -.01$, $SE = .21$, $t = -0.03$, $p = 1.00$).

As a second manipulation check, five undergraduate raters (one male and four females, mean age = 20), blind to both the content of the emotion induction tasks and the sex of the participants, independently rated the emotional content of the essays with regard to the degree to which eight different emotions (anger, disgust, romantic love, non-romantic love, mirth, contempt, moral outrage, and sexual arousal) were expressed in the essay (the additional emotions listed were selected based on research interests beyond the scope of this paper; Campbell's (2002) hypothesis had not yet been published at the time of our study, hence we did not include fear among the emotions to be evaluated). Using an unbiased estimate of variance (Winer, 1971), the mean interrater reliability for coding the presence of these eight emotions in the essays was .73. For the two emotions of interest in the present analysis, reliability was as follows: anger = .90, disgust = .93. In light of the high level of interrater reliability, scores were averaged across all five raters.

Raters found significantly more anger content in essays written by participants in the anger condition ($B = 6.97$, $SE = .38$, $t = 18.31$, $p < .001$) than in those produced by participants in the control condition, but did not find significantly more disgust content ($B = .08$, $SE = .11$, $t = 0.74$, $p = .46$). There were no sex differences in either the amount of anger ($B = .15$, $SE = .76$, $t = 0.20$, $p = .84$) or disgust ($B = .23$, $SE = .23$, $t = 1.03$, $p = .31$) expressed in the anger essays.

Raters found significantly more disgust content ($B = 6.70$, $SE = .77$, $t = 8.67$, $p < .001$) and significantly more anger content ($B = 3.94$, $SE = .58$, $t = 6.75$, $p < .001$) in essays written by participants in the disgust condition than in those produced by the control condition.

There were no interactions of emotion induction condition with sex on either disgust content ($B = -1.04$, $SE = 1.55$, $t = -0.67$, $p = .51$) or anger content ($B = 1.74$, $SE = 1.17$, $t = 1.49$, $p = .14$).

Raters' assessments of the affective content of the essays largely matched self-reported affect on the PANAS-X—the correlation between the two measures of anger was .52 ($p < .001$), and the correlation between the two measures of disgust was .49 ($p < .001$).

Risk taking in the control condition

Among participants in the control condition, there were no sex differences in risk taking on the Choice Task ($B = -.09$, $SE = .35$, $t = -0.26$, $p = .80$).

Emotional arousal and risk taking

Due to the strong correlation between self-reported risk taking behaviors and performance on the experimental task, the composite risky behaviors scale was included in all analyses of the dependent variable. Because feelings of anger and disgust were highly positively correlated with one another in participants' self-reports ($r = .61, p < .001$) (though not in raters' evaluations: $r = -.17, p < .05$), in all analyses of the dependent variable, the non-target emotion was statistically controlled to eliminate the confounding effects of that emotion. Self-reported fear was statistically controlled across all conditions.

Anger and risk taking

The main effect of anger on risk taking failed to reach significance, but exhibited a clear trend such that those individuals who were made to feel angry were more likely to make risky decisions than those in the control condition ($B = .49$, $SE = .29$, $t = 1.66$, $p = .10$). There was, however, a significant interaction of emotion induction condition and sex of participant ($B = -1.06$, $SE = .50$, $t = -2.13$, $p < .05$). Among men, those in the angry condition chose significantly more chance options than those in the control condition ($B = 1.01$, $SE = .38$, $t = 2.66$, $p = .01$, see Fig. 1). Among women, there was no difference in the number of chance options chosen based upon emotion condition ($B = -.04$, $SE = .39$, $t = -0.11$, $p = .92$). There was also a main effect of self-reported risky behaviors on performance in the choice task ($B = 1.06$, $SE = .47$, $t = 2.25$, $p < .05$).

Disgust and risk taking

In the disgust condition, there was no main effect of emotion induction condition on risk taking ($B = -.25$, $SE = .29$, $t = -0.86$, $p = .18$). However, there was again a significant interaction of emotion induction condition and sex of participant on risk taking ($B = -1.28$, $SE = .29$, $t = -2.43$, $p < .05$). Women in the disgust condition chose significantly fewer chance options than women in the control condition ($B = -.96$, $SE = .45$, $t = -2.12$, $p < .05$, see Fig. 2). Men in the disgust condition did not show any difference in risk taking compared to men in the control condition ($B = .26$, $SE = .58$, $t = 0.39$, $p = .70$). Once again, there was a significant effect of individual differences in self-reported risky behavior on performance in the experimental task ($B = 1.09$, $SE = .50$, $t = 2.16$, $p < .05$).

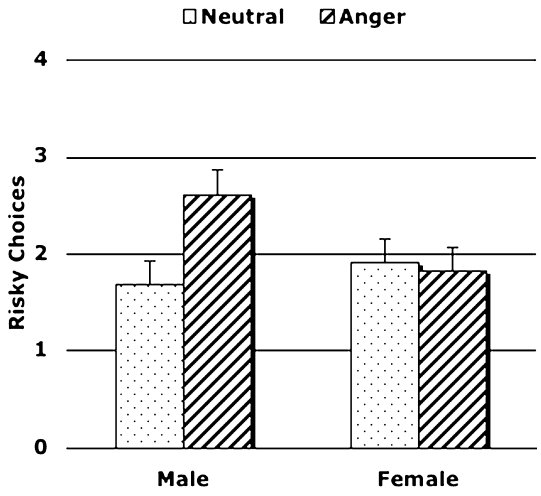

Fig. 1. The effect of the emotion induction condition "Anger" on men's and women's risk-taking, as measured by number of chance options chosen in the Choice Task (means adjusted by individual differences in risk-taking and non-target emotions).

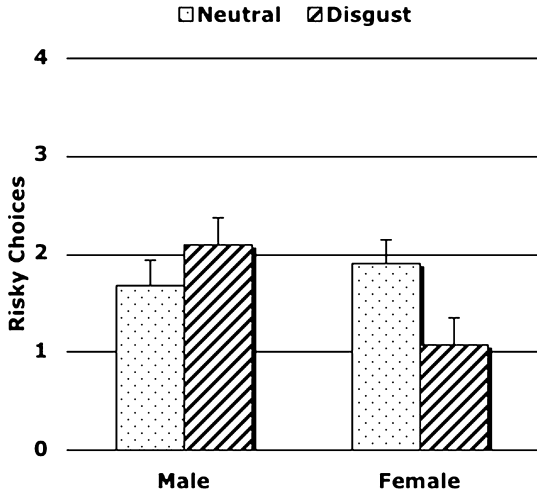

Fig. 2. The effect of the emotion induction condition "Disgust" on men's and women's risk-taking, as measured by number of chance options chosen in the Choice Task (means adjusted for individual differences in risk-taking and non-target emotions).

Discussion

Consistent with our predictions regarding both the respective impacts of anger and disgust on risk taking

and sex differences in such effects, our examination of decisions concerning substantial real monetary stakes revealed that, among men, participants in the anger condition selected a larger number of risky choices than those in the control condition, yet there was no difference in this regard between the disgust condition and controls. Conversely, among women, while participants in the anger condition did not differ in their choices from controls, participants in the disgust condition selected significantly fewer risky choices than those in the control condition.

Self-report scores on the PANAS-X and raters' evaluations of participants' essays indicate that our manipulations successfully induced the target affects, producing significant differences in emotional states between the experimental conditions and the control condition. Consistent with both: (a) the thematic associations between anger and disgust (Nabi, 2002; Smith & Ellsworth, 1985), and (b) the tendency for induction procedures to sometimes elicit multiple emotions (Polivy, 1981), participants in each of the experimental conditions also reported more of the other target emotion than did participants in the control condition; a similar overlap occurred with regard to raters' evaluations of essays produced by participants in the disgust condition. In our analysis, we compensated for this overlap by controlling for the degree of elicitation of the non-target emotion.

The sex differences present in our results are unlikely to be due to differences in the strength of the induction of the target emotions. Raters found no sex differences in the amount of either target emotion expressed in the essays written by participants in the experimental conditions. More directly, scores on the PANAS-X indicate that male and female participants in the anger condition reported equal levels of anger, while in the disgust condition women reported less disgust than men, the opposite from what would be expected if women's greater reduction in risk taking following disgust induction was due to a sex difference in elicitation.

Our results are not explicable in terms of Campbell's (2002) hypothesis that the sex difference in risk taking in response to anger-eliciting situations is due to greater concomitant fear in women, as men and women in the anger condition did not differ in level of self-reported fear (and, in addition, the sex difference in the impact of anger on risk taking was clearly evident even though self-reported fear was statistically controlled). We therefore conclude that, as we predicted, anger operates in a sexually dimorphic fashion independent of any contributions that fear may make to sex differences in risk taking. We similarly interpret our disgust results as indicating that, in addition to sex differences in disgust sensitivity, sexual dimorphism characterizes the operational consequences of this emotion for risk taking. The conclusion that emotions can influence risk taking in a sexually dimorphic fashion may shed light on some of the apparently contradictory findings reported in the literature, as it is possible that differences in the sex ratios of samples contributed to the divergent results obtained across investigations.

Although we found sex-specific effects of emotions on risk taking, these were measurable only in terms of the number of chance options selected—angry men selected more of the risky choices, and disgusted women selected fewer of the risky choices, but neither category differed in terms of the tendency to select choices with lower versus higher odds of success. This may reflect the complexity of the method employed—because the Choice Task was administered orally, participants may have had difficulty contemplating the options in detail, and may therefore have simply dichotomized them as either certain or risky. Alternately, it is possible that the process whereby emotions influence risk taking involves a simple categorization of options as either risky or non-risky (cf. Loewenstein et al., 2001, pp. 276–277), in which case modifications of the Choice Task (such as training sessions in advance of emotion induction) should have no effect.

We believe that our demonstration that two negative emotions exert diametrically opposed influences on risk taking adds additional evidence to the case against valence-based theories of the impact of emotions on decision making. Similarly, while the study of appraisals associated with specific emotions may shed light on the interaction of affective and cognitive systems, given that our evolutionary functionalist perspective successfully predicted differences in the behavioral consequences of anger and disgust, whereas Lerner and Keltner's appraisal-tendencies theory predicted only similarities, we feel that our approach provides a more fruitful framework for understanding the impact of emotions on risk taking.[1]

Abandoning an appraisal-tendency perspective on emotions in favor of an evolutionary functionalist one comes at some cost, as the latter is more difficult to operationalize. Targeted investigations such as those of Smith and Ellsworth (1985) suffice to identify appraisal tendencies. In contrast, while the ultimate functions of some emotions are obvious, this is not true of others. Some of the most productive insights concerning the functions of emotions have been generated by game theoretic analyses (e.g., Frank, 1988; Hirshleifer, 1987), inviting collaboration between theorists who produce hypotheses regarding the utility of specific emotions

[1] Our results also call into question Leith and Baumeister's (1996) claim that only high arousal negatively valenced emotions influence risk taking. Disgust involves even lower arousal than sadness (Scherer & Wallbott, 1994, p. 321), the low arousal negative emotion employed by Leith and Baumeister, hence, according to their formulation, disgust should have had no effect on risk taking.

and empiricists who use these hypotheses to generate predictions regarding the impacts of said affects on risk taking.

In addition to providing grounds for evaluating the usefulness of various competing theories for predicting the impact of specific emotions on risk taking, our results shed additional light on the general role of affect in decision making. Our method of emotion induction was blatant, indicating that, despite the substantial stakes at issue, participants' risk taking behavior was influenced by emotions the sources of which were obviously unconnected to the decision at hand. Our findings therefore support the view that emotions constitute a relatively autonomous channel of influence on decision making, operating in conjunction with, but largely independent of, more strictly cognitive processes (Clore, Gasper, & Garvin, 2001; Ketelaar & Clore, 1997; Loewenstein, 2000; Loewenstein et al., 2001).

Limitations

Although we predicted that anger should increase risk taking less among women than among men, and that disgust should decrease risk taking less among men than among women, we found more extensive sex differences, with anger having no significant effect on female risk taking, and disgust having no significant effect on male risk taking. An evolutionary functionalist perspective suggests that it is unlikely that anger and disgust have no impact on risk taking in women and men, respectively. Rather, the orally administered Choice Task, with its weak internal consistency, is probably too crude a measure of risk taking to capture these more muted effects. The latter explanation is consistent with the absence of a sex difference in risk taking among participants in the neutral condition, a pattern that contrasts with others' reports of greater male risk taking in the financial/gambling domain (Eckel & Grossman, 2002; Johnson, Wilke, & Weber, n.d.; Weber, Blais, & Betz, 2002).

Our results should be considered preliminary given that: (a) the most ecologically valid measures of the impact of emotions on risk taking are those that include not only risk but also uncertainty (Hockey et al., 2000), and (b) decisions made on the basis of probability assessments derived from experience differ from those made on the basis of stated probabilities (Weber, Shafir, & Blais, 2004). Our findings should also be treated with caution given that, whereas in the Choice Task risk concerns potentially lost gains, risk taking in daily life often involves potential losses from baseline. Although findings regarding the endowment effect (Kahneman, Knetsch, & Thaler, 1991) suggest that it might be possible to simulate losses from baseline by allowing participants to possess and handle a sure payoff sum prior to decision making, consistent with the house money effect (Thaler & Johnson, 1990), metaanalysis reveals that this technique increases risk taking (Weber et al., 2004), a pattern opposite to what one might expect if the method simulated losses from baseline.

The risky behaviors inventory was included in order to allow us to control for individual differences in the propensity to take risks. Although scores on the 20-point risky behaviors scale did correlate with performance on the Choice Task, it is nevertheless likely that the measure was only partially successful. Importantly, we failed to include financial risk taking in our inventory, yet behavior in gambling-type tasks correlates incompletely with decision making in non-gambling domains (Goldstein & Weber, 1997; Johnson et al., n.d.), and self-reported gambling behavior correlates only partly with self-reports of other forms of risk taking (Johnson et al., n.d.; Weber et al., 2002).

Because risk taking appears to be somewhat domain-specific (Johnson et al., n.d.; Weber et al., 2002), our results do not prove that anger and disgust exercise the same influences on risk taking in all domains. Indeed, an evolutionary perspective suggests that the patterns that we have documented should vary somewhat across domains. For example, although anger is predicted to generally have a more muted impact on risk taking among women, because women's reproduction is more constrained than men's, thus causing a given offspring to often be more important to the mother's fitness than to the father's, the sex difference in the effect of anger on risk taking should be diminished in cases where the eliciting transgression involves threats to one's child (Campbell, 2002, pp. 94–99). Additional investigations using measures of risk taking in non-financial domains are therefore in order.

There is some evidence that the sexes differ on measures of the physiological correlates of anger and disgust even when self-reports are held constant, with men being more reactive to exogenous anger-eliciting stimuli and women being more reactive to exogenous disgust-eliciting stimuli (Kring & Gordon, 1998; see also review in Kring, 2000). Because we did not measure physiological responses, despite the absence of a sex difference in both of our manipulation checks, we cannot rule out the possibility that the sex differences which we have found reflect differences in anger and disgust reactivity rather than dimorphisms in the operation of these emotions at a given level of intensity.

Future directions

An evolutionary perspective suggests that the utility of male risk taking in response to transgression is greater for young men than for older men, as the former enter the competitive arena without an established reputation

in this regard, and with little to lose (Wilson & Daly, 1993). Likewise, the hazards posed to women by contaminants are greatest during the reproductive years. Together, these observations suggest that both the impact of anger on male risk taking and the impact of disgust on female risk taking should decrease across adulthood (compare with Loewenstein et al., 2001, p. 280). A sample encompassing wider age ranges than that employed here would allow for the investigation of these possibilities.

Personality, which exercises a direct effect on likelihood estimations independent of state affect (Zelenski & Larsen, 2002), may also moderate the effects of anger and disgust on risk taking (cf. Hockey et al., 2000; Rusting & Nolen-Hoeksema, 1998); self-esteem may prove to be an especially important moderator of the impact of these emotions (Kirkpatrick, Waugh, Valencia, & Webster, 2002). Individual differences in the degree to which emotions are attended to also likely impact their effects on risk taking, particularly in experiments involving induction (DeSteno et al., 2000; Gasper & Clore, 2000). Although we did not investigate individual differences in traits such as need for cognition, doing so may shed further light on the ways in which anger and disgust influence risk taking behavior.

In addition to specific predictions regarding sex differences in the effects of anger and disgust, an evolutionary approach also suggests overarching sex differences in the propensity to take risks. Because the potential variance in female reproductive success is much lower than that in male reproductive success, females generally profit from a low-risk strategy that emphasizes steady returns. In contrast, males have more to gain and less to lose from risk taking (Daly & Wilson, 1988; Eckel & Grossman, 2002; Rubin & Paul, 1979; Wilson & Daly, 1985). In addition to accounting for sex differences in risk estimations such as those reported by Lerner et al. (2003), this reasoning suggests that any mechanism that increases risk taking can be expected to generally exercise a stronger effect on males, while any mechanism that decreases risk taking can be expected to generally exercise a stronger effect on females. While domain-specific effects may sometimes fail to conform to the predicted pattern, this generalization can nonetheless usefully inform a wide range of investigations of the effects of emotions on risk taking.

Shame and embarrassment may be productive targets for future investigations of the influence of emotions on risk taking. Though closely linked in English, shame and embarrassment are distinct emotions, each associated with a unique functional objective. Shame marks a drop in social standing caused by a significant failure to live up to standards for behavior. Because a drop in social standing is associated with a decrease in future prospects, and because the value of taking risks is inversely related to such prospects, shame can be expected to increase risk taking (Fessler, 2001a). Embarrassment, which marks an unintentional violation of a norm, motivates appeasement in the service of reincorporation (Keltner & Buswell, 1997). Because the goal of such action is to reassure others of one's social acceptability (Leary, Landel, & Patton, 1996), embarrassment can be expected to enhance caution with regard to norm conformity, decreasing risk taking in this domain. Although Baumeister and associates (Baumeister, Heatherton, & Tice, 1993; Leith & Baumeister, 1996) have employed manipulations that likely induced shame and embarrassment, their methods did not differentiate between these emotions.

We did not examine the proximate mechanisms whereby emotions influence risk taking. Further exploration of the effects of emotions on the coloring of subjective probabilities, the weighting of costs versus benefits, the subjective utility of various outcomes, and the rapidity with which decisions are made may prove productive, and may shed light on the decision making processes that produced the results documented here.

Appendix A. Oral instruction script for choice task and emotion induction

- I would like to explain to you what we will be doing today.
- In a few minutes, we are going to do what is called a choice task.
- You will be given four sets of choices.
- In each set, you will be asked to choose between two options.
- One of those options will be a guaranteed sum of money; and the other will be a chance to win some greater amount of money with a known probability.
- You should make each choice independently of the other choices.
- After you have made all four choices, we will randomly select one set of choices using this spinner (*show spinner*).
- If you chose the guaranteed payment in that set, you will receive that amount of money.
- If you chose the chance to win in that set, you will play a lottery-style game for the greater amount of money.
- I will put 20 marbles of two different colors into a bag, in the appropriate proportions.
- You will blindly remove one marble from that bag.
- If you draw a black marble, you win; if you draw a clear marble, you do not.

- For example, if the choice set that gets selected includes a 50/50 chance to win, and you chose that option, I would put 10 black marbles and 10 clear marbles into the bag.
- You will draw one marble from the bag.
- If you draw the black marble, you will get the money, and if you draw the clear marble, you will not.
- If you had chosen the guaranteed option, of course, you would get the set amount of money no matter what.
- Do you have any questions?
- Great. Now, before we do that, I would like you to complete a small visualization task.
- You will write for a few minutes about whatever the instructions inside this envelope say (*hold up envelope*).
- I don't know which set of instructions you've gotten, and to ensure your privacy, I'll knock on the door in a couple of minutes, at which time you should put the form back in the envelope and seal it.
- I'll come back in the room then, and we will do the choice task.
- Don't worry about style, spelling, or grammar, just read carefully and follow the instructions.
- It's very important that you concentrate on this.
- What you write will be completely anonymous, and the envelope will not be opened until the entire project is complete.
- Do you have any (other) questions?

Appendix B. The choice task

This form to be filled out by the experimenter. Participant ID #: _____

READ ALOUD: There are four rounds in this game. For each round, you will choose one option, either option 1 or option 2. Each decision should be made independently of the decisions made in every other round. One round will be randomly selected, and you will be paid only according to the choice you made for that round.

Round A:
Do you prefer:
1. $15 (guaranteed) OR 2. $18.75 (16 out of 20; 80%)

Round B:
Do you prefer:
1. $15 (guaranteed) OR 2. $37.50 (8 out of 20; 40%)

Round C:
Do you prefer:
1. $15 (guaranteed) OR 2. $75.00 (4 out of 20; 20%)

Round D:
Do you prefer:
1. $15 (guaranteed) OR 2. $300.00 (1 out of 20; 5%)

Round selected for payment:_____ Total payment made:_____

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