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Relative status regulates risky decision making about resources in men: evidence for the co-evolution of motivation and cognition

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Abstract

Relative social status strongly regulates human behavior, yet this factor has been largely ignored in research on risky decision making. Humans, like other animals, incur risks as they compete to defend or improve their standing in a social group. Among men, access to culturally important resources is a locus of intrasexual competition and a determinant of status. Thus, relative status should affect men's motivations for risk in relevant domains. Contrasting predictions about such effects were derived from dominance theory and risk-sensitive foraging theory. Experiments varied whether subjects thought they were being observed and evaluated by others of lower, equal or higher status, and whether decisions involved resources (status relevant) or medical treatments (status irrelevant). Across two experiments, men who thought others of equal status were viewing and evaluating their decisions were more likely to favor a high-risk/high-gain means of recouping a monetary loss over a no-risk/low-gain means with equal expected value. Supporting predictions from dominance theory, this motivation for risk taking appeared only in the equal status condition, only for men, and only for resource loss problems. Taken together, the results support the idea that motivational systems designed to negotiate a status-saturated social world regulate the cognitive processes that generate risky decision making in men.

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1. Introduction

Researchers in judgment under uncertainty have argued that biases, fallacies and framing effects explain much of the apparently nonfunctional variation in human decision making. Recent work by evolutionary researchers shows, however, that many decisions that appear irrational by mathematical standards are ecologically rational — that is, produced by computational systems well engineered for achieving adaptive performance on evolutionarily recurrent tasks (Brase, Cosmides, & Tooby, 1998; Cosmides & Tooby, 1996; Gigerenzer & Selton, 2001; Haselton & Nettle, 2006; Rode, Cosmides, Hell, & Tooby, 1999; Wang, 1996a, 1996b). For example, ambiguity aversion is often thought to be a stable and irrational bias in human decision making. Subsequent experiments have shown, however, that it is an easily reversible product of a powerful adaptive system designed for risky decision making (Rode et al., 1999). The design of this system is ecologically rational, conforming to a functional logic specified by the evolutionary theory of risk-sensitive foraging (Rode et al., 1999).

Here we explore two additional possibilities involving risky decision making. First, risky decision making may not be a unitary phenomenon; it might fractionate into several more evolutionarily specialized subdomains, each activating different evolved decision-making principles. For example, although resource acquisition can occur during foraging or status competition, status competition may activate an evolved system for making risky decisions about resources that is distinct from those activated by foraging and other contexts.

Second, if risky decision making does fractionate along motivational lines (e.g., status relevant vs. status irrelevant),

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this may have implications for the evolution of motivation and cognition. Motivation is often treated simply as a system that plugs exogenous preferences (such as utilities) into uniform and domain-general cognitive procedures. We suggest, however, that a more satisfying account of decision making can be achieved by hypothesizing that motivational and cognitive mechanisms co-evolved to operate in coordinated, domain-specific ways. On this account, a given motivational system is equipped with its own distinct and proprietary cognitive mechanisms, which are designed to interact with regulatory variables (e.g., representations of relative status) in ways that produce highly domain-specialized (and adaptively well-engineered) patterns of risky decision making.

One virtue of taking an evolutionary approach is that, in many cases, there already exist powerful, precise theories of how functional systems ought to be designed. In this case, we believe that dominance theory, drawn from the evolutionary biology of animal conflict (Hammerstein & Parker, 1982; Maynard Smith, 1974; Maynard Smith & Price, 1973), can be used to predict patterns in risky decision making in conditions involving social competition. Indeed, many social species are known to have evolved motivational systems designed for successfully navigating dominance and status interactions (Archer, 1988). These systems use information about relative status to regulate decisions to risk harm and loss in pursuit of resources — or status itself. Humans likewise evolved in social groups in which status and dominance relationships regulated access to resources. This fact leads to the expectation that humans have also evolved a motivational system designed to regulate willingness to take competitive risks in dominance-relevant contexts.

Researchers typically operationalize risky decision making as a choice between two options that are equal in average expected payoff — one certain (win US$20), the other risky (1/3 chance of winning US$60, 2/3 chance of getting nothing). Evolutionarily, the question posed to the organism is not what choice yields the highest direct payoff, but what choice typically yielded the most fitness-promoting payoff. Often these converge. However, risky decisions that have implications for status and dominance entail social costs and benefits beyond the immediate resources lost or gained — ones which do not apply to risky decisions in pursuit of foraged plants, predator evasion and other domains. Such analyses led us to propose that men's minds are equipped with evolved domain-specific decision-making mechanisms designed to regulate competitive risks in response to cues of relative status. Herein we test for the existence of such mechanisms, using risky choice problems that have been classic research tools in the cognitive literature on judgment under uncertainty.

1.1. Resources and intrasexual competition in men

Computational systems designed to regulate intrasexual competition should exist in the brains of both men and women, but their designs should be sexually dimorphic.

Across cultures, women prefer men with higher status and access to culturally valued resources as mates (Buss, 1989). In comparison, men's mate preferences are relatively insensitive to variations in the status and resources of women (Buss, 1989; Townsend, 1989). Not surprisingly, then, status gained through access to culturally valued resources plays a more important role in intrasexual competition among men than among women (Buss, 1992). For example, male–male homicide rates increase with income inequality, suggesting that young men's minds are designed to up-regulate motivations to take competitive risks in response to cues that their mating opportunities are limited by lack of resources (Daly, Wilson, & Vasdev, 2001).

Based on these well-documented facts, we predicted that motivational systems designed to regulate competitive risk taking in the service of achieving and maintaining status will be activated by situations involving resource acquisition in men, but not in women.

Preliminary evidence is consistent with this hypothesis. Men's risky decision making is influenced by whether others are watching, and possibly evaluating, their actions: when betting for real money, the presence of peers facilitates willingness to choose high-risk/high-gain gambles in young men, but not in young women (Daly & Wilson, 2001). Our goal is to test whether men's motivation for competitive risk taking is regulated not just by the presence of observers, but also by their status relative to them.

To test for status-regulated features predicted to exist in a computational system shaped by selection pressures for male–male intrasexual competition, we conducted experiments in which subjects believed individuals of the same sex were observing and evaluating their actions, and varied the status of the subject relative to these (alleged) observers. We also varied whether the domain of risk was status relevant (resources) or status irrelevant (medical treatments). Prospect theory (Kahneman & Tversky, 1973, 1979; Tversky & Kahneman, 1981) and other approaches to risky decision making found in the cognitive literature make no predictions about how sex, domain of risk or status of observers regulate risk taking. But two theories from behavioral ecology can be applied to make predictions about how, specifically, men's risky choices about resources should be regulated by social status: risk-sensitive foraging theory and dominance theory.

1.2. Risk-sensitive foraging theory

According to risk-sensitive foraging models (Stephens & Krebs, 1986), an organism's need level should regulate risky decision making, in conjunction with the statistical parameters associated with each choice. If two foraging patches have the same mean caloric return, but differ in outcome variance, then the best choice depends on the organism's state. When the forager needs more than the mean expected return to survive, the chances of meeting that need level are maximized by choosing the high-variance (i.e., risky) patch. The low-variance patch is the safer choice only when the forager's survival needs are less than or equal to its mean

return. Risk-sensitive foraging models have successfully predicted animal foraging (e.g., Real & Caraco, 1986).

Moreover, this model appears to successfully predict human risky decision making, even on complex tasks that exceed the capacity of subjects to make deliberative calculations (e.g., Rode et al., 1999; Wang, 1996a). These results imply that the human mind contains a nonconscious specialization that embodies these decision-making principles.

The logic of these models is general: choosing risk is more likely to meet one's aspiration level whenever mean expected outcomes fall below the minimum to which one aspires — whether one's minimum aspiration is for a specified number of calories or a specified level of status. By positing an aspiration level for status, this approach can be applied to the current research. Social status is always relative: having a high or low level depends on the current comparison group. Thus, one might expect men to have a relatively constant aspiration for higher status relative to others. If men seek resources to gain higher relative status, this model predicts they will seek risk when their status is lower than or equal to the status of the men observing and evaluating their actions (because their status aspiration level has not yet been met) and avoid risk when their own status is higher (because their status aspiration level has already been satisfied). On this view, risky decisions are regulated by domain-general decision rules, and men and women differ only because the domain of resource acquisition fits the input conditions for potential status gains in men, but not in women.

1.3. Dominance theory

The second perspective from behavioral ecology that may prove relevant to understanding the evolution of risky decision making in humans is dominance theory, which is based on analyses of animal conflicts and assessment strategies (Archer, 1988; Hammerstein & Parker, 1982; Maynard Smith, 1974; Maynard Smith & Price, 1973).

According to dominance models, such as the asymmetric war of attrition (Hammerstein & Parker, 1982), motivations to risk injury in pursuit of resources are jointly regulated by the relative value of a resource to both contestants and their relative ability to harm one another. When both contestants value a resource equally and one is clearly able to inflict more harm than the other in a fight, the less formidable individual is better off ceding the resource rather than risking injury in a fight he is sure to lose. This model predicts the evolution of low-cost displays through which the relative ability to inflict harm can be reliably assessed; in stable social groups, these assessments should lead to the emergence of dominance ranks (Barnard & Burk, 1979; Clutton-Brock & Albon, 1979).

If a stable dominance hierarchy has emerged, discrepancy in relative rank should regulate motivations to take risks to defend (or acquire) a resource. When ranks are clearly different (and both value the resource equally), the evolutionarily stable strategy is for lower ranking individuals to defer to the resource demands of higher ranking ones. Motivations for risk taking should be low in both contestants because both benefit by this — lower ranked individuals do not incur major injuries fighting for resources they will fail to obtain, and higher ranked individuals obtain those resources without the costs of a contest (lost time, energy and risk of injury).

Payoffs change, however, when contestants are of similar rank; challenges should increase, as well as motivation to defend against these challenges. As a result, motivations to take risks in pursuit of resources should be up-regulated when two individuals believe themselves to be equal in rank. Displays of cues relevant to assessing the contestants' relative ability to inflict harm should escalate until both assess that an asymmetry in the ability to inflict harm exists, leading one of them to cede the resource. If this does not happen through displays, a fight may ensue to decide who gets the resource. Indeed, among humans, many male–male conflicts with escalating violence begin as disputes over "respect," where a status challenge from an approximate equal cannot be ignored (Wilson, Daly, & Pound, 2002).

Note that others benefit by being observers — indeed, many species have evolved the ability to infer a dominance hierarchy just by watching the contests of others, and individuals use these inferences to regulate their own decisions to risk a fight (e.g., Grosenick, Clement, & Fernald, 2007). The presence of third parties should magnify any effects of status on one's risk taking, because losing rank in a contest may lead observers of similar status, in addition to the current rival, to expect deference.

In these models, harm is conceptualized as risk of physical injury. To accommodate the human case, they can be generalized to include social harms, such as risk that a higher status individual will withdraw cooperation or access to other social benefits if the resource is not ceded. Generalized to include status ranks, dominance theory predicts that men's motivation to take risks in pursuit of resources will be highest when two men of equal status want the same resource.

Men might not need to be in a direct competition for resources for this motivation to emerge: given that observers may infer a man's rank from his choices, believing that men of equal status will be watching and "evaluating" their choices may be sufficient to up-regulate men's motivations to choose risk in pursuit of resources.

Note that dominance theory and risk-sensitive foraging theory both predict higher risk taking when men are facing status equals, but their predictions diverge for cases in which the status of the observers is different from that of the subject.

1.4. Predictions

The theory and evidence above motivated our main hypotheses:

(i) Relative social status will regulate men's choices in risky decision making about resources.

(ii) The joint presence of resource opportunities and status rivals will not elicit indiscriminate risk taking in men. We compare two possibilities:

  (a) If men's risk-taking motivations result from an aspiration for higher status plugging into general risky decision-making mechanisms, as on the risk-sensitive foraging account, then relative status will up-regulate men's willingness to take risks when their aspiration for higher status has not been met (i.e., when their relative status is lower than or equal to that of their potential evaluators).

  (b) If, on the other hand, men's risk-taking motivations result from a motivational system that was shaped by selection pressures specified by dominance theory, then relative status will up-regulate men's willingness to take risks only when they face status equals (and not when they face potential evaluators of lower or higher status).

(iii) The effects of status on men's risk taking should be domain specific: relative status will not regulate men's risk-taking motivations in domains that were not relevant to intrasexual competition, such as medical decisions.

(iv) The pattern described by i–iii will be specific to men: relative status will not regulate women's choices in risky decision making about resources or medical decisions.

2. Experiment 1

We used risky decision problems to test the hypotheses listed above; the contrasting predictions of dominance and risk-sensitive foraging theory are summarized in Table 1. We began with resource problems that involve the opportunity to recoup money that had been lost to others. Money was used because it is a culturally valued, status-conferring resource for North American subjects.

A loss situation was first explored because prior results, including some from prospect theory, show that loss is more likely to trigger risk-seeking choices (Kahneman & Tversky, 1973, 1979). This effect makes sense on several theoretical grounds. First, having just lost resources may be seen as a status blow that needs to be repaired; if so, loss is more likely to trigger risk taking in pursuit of status-conferring resources, on all theories of status and risk. Second, the marginal value of a unit of resource is higher after resource loss; the other factor up-regulating risk motivations in dominance theory is the value of the resource (more risk taking for higher value resources). Third, a drop below baseline is more likely to trigger risk taking on risk-sensitive foraging accounts (Rode et al., 1999): after loss, even more is needed to meet any given aspiration level.

Table 1
Comparison of predictions derived from risk-sensitive foraging theory and dominance theory about men's risky choices on the resource loss problem

	Subject's relative social status		
	Lower (L) vs. equal (E)	Equal (E) vs. higher (H)	Lower (L) vs. higher (H)
Predictions (% choosing risk)			
Risk-sensitive foraging	L=E	E>H	L>H
Dominance theory	L<E	E>H	L=H
Results			
% Choosing risky option			
Experiment 1	43 vs. 79	79 vs. 29	43 vs. 29
Experiment 2	24 vs. 64	64 vs. 33	24 vs. 33
Conclusion			
Experiment 1	L<E *	E>H **	L=H
Experiment 2	L<E **	E>H *	L=H
Predictions supported?			
Risk-sensitive foraging	No	Yes	No
Dominance theory	Yes	Yes	Yes

 * $p<.05$.
 ** $p<.01$.

To manipulate relative status, subjects were led to believe that same-sex individuals from another college would be observing and evaluating their choices. The evaluators' college varied across conditions: subjects viewed graduates of their own college as having either lower, equal or higher status than graduates of the evaluators' college.

2.1. Method

2.1.1. Subjects

Ninety-four students (42 men, mean=19.6 years, S.D.= 1.12) from Franklin & Marshall College (F&M) participated in this experiment. They were recruited from introductory and upper-level psychology classes and received course credit for their participation.

2.1.2. Measures and experimental manipulations

2.1.2.1. Decision problems. Subjects completed two different forced choice decision problems: a problem about monetary resources (resource loss problem) and a structurally equivalent control problem about medical treatments (medical loss problem). (A third problem was also presented, but a wording error made results uninterpretable.) The problems used were versions for which Wang (1996c) reported no significant framing effects. On each problem, subjects were asked to choose between a sure (deterministic) option and a risky (probabilistic) option with equal expected value. Order and frame of the problems were counterbalanced and randomly assigned across subjects. Examples of the problems used are below, with the sure option (A) first and the risky option (B) second (order of options was also counterbalanced).

Resource loss problem (positive frame; i.e., framed as probability of saving rather than losing money):

Imagine that you bought $60 worth of stock from a company that has just filed a claim for bankruptcy. The

company now provides you with two alternatives to recover some of your money.

If you choose Alternative A, you will save $20 of your money.

If you choose Alternative B, you will take part in a random drawing procedure with exactly a one-third probability of saving all of your money and a two-thirds probability of saving none of your money.

Which of the two alternatives would you favor?

Medical loss problem (negative frame; framed as probability of dying rather than surviving):

Imagine that 60 people are infected by a fatal disease. Two alternative medical plans to treat the disease have been proposed. Assume the exact scientific estimates of the consequences of the plan are as follows.

If you choose Plan A, 40 people will die.

If you choose Plan B, there is a two-thirds chance everyone will die and one-third chance no one will die.

Which of the two plans would you favor?

2.1.2.2. Social status. Colleges for the (sham) evaluators were selected from a survey of 130 other F&M students, who rated both the social status of a graduate from various colleges and universities and their familiarity with those schools from low to high on 1–7 Likert scales. On the basis of these ratings, three comparison colleges were chosen: Princeton University (status higher than F&M), Swarthmore College (status equal to F&M) and Gettysburg College (status lower than F&M). Subjects were randomly assigned to one of three relative status conditions: subject's status lower (i.e., evaluators from higher status Princeton University), equal (evaluators from equal status Swarthmore College) or higher (evaluators from lower status Gettysburg College). Because the predicted effects would result from maintaining or improving one's standing in intrasexual competition, subjects were told that the students who would evaluate their decision making were of the same sex as themselves.

2.1.2.3. Demographics and social status manipulation check. Following the decision problems, subjects were asked for basic demographic information: age, sex, year in school and race. As a manipulation check, subjects rated the social status of a graduate of the schools used and their familiarity with these schools, from low to high on 1–7 Likert scales.

2.1.3. Procedure

Subjects were tested individually. They were told that the experimenter was interested in people's perceptions of others' decisions. The experimenter explained that subjects would be videotaped while making their decisions, and that their decisions would be seen and evaluated by students from college X (Princeton, Swarthmore or Gettysburg). To increase the plausibility, they were asked to sign two forms

agreeing to be videotaped and to release their videotape to the other school. Next, each subject was led into an adjoining room and seated in front of a video camera. Each subject responded to the decision problems orally and by circling their choice on a chalkboard, while being "videotaped." After this part, the video camera was ostensibly turned off as the subject completed the demographics and manipulation check questionnaire. Subjects were debriefed after the completion of data collection. At this point, they were informed that videotaping did not in fact occur and that no one from any other institution would see or evaluate their responses.

2.2. Manipulation checks and preliminary analyses

2.2.1. Social status

Subjects did in fact perceive graduates of the selected schools as differing in status in the intended directions. The mean social status rating of F&M graduates (5.7, S.D.=0.68) was significantly lower than the mean social status rating of Princeton graduates (6.5, S.D.=0.87; t(91)=−8.31, $p<.01$, $r=.66$), significantly higher than the mean rating of Gettysburg graduates (4.6, S.D.=0.96; t(90)=10.68, $p<.01$, r=.75) and not significantly different from the mean rating of Swarthmore graduates (5.8, S.D.=0.98; t(91)=−0.83, $p=.41$, r=.09).

2.2.2. Framing effects

Framing effects were either nonexistent (resource problem) or marginal (medical problem), so data from positive and negative frames of each problem were combined in testing the predicted effects of social status on decision making. (Even if strong framing effects had been found, they could not explain status effects because positive and negative frames for each problem were counterbalanced across subjects.)

2.3. Results and discussion

The most important results are shown in Fig. 1 and Table 1. They are expressed as the percent of subjects choosing the risky option when the subject's status is lower (L), equal (E) or higher (H) than that of his or her (sham) evaluators. All p values are two tailed.

For men, resources were (and are) an arena of intrasexual competition. When resources were at stake, did men's relative status affect how often they chose the risky option? Yes. As predicted, relative social status significantly affected how often men chose the risky option on the resource loss problem (subject's status: lower=43%, equal=79%, higher=29%; $\chi^2(2, n=42)=7.43$, $p=.02$, $\varphi=.42$).

Does the pattern of men's risky choices about resources fit the predictions of risk-sensitive foraging theory or dominance theory? Planned comparisons were conducted to test the predictions derived from risk-sensitive foraging theory and dominance theory (Table 1). These comparisons clearly supported dominance theory: men who thought they were being evaluated by status equals chose the high-risk/high-gain option for acquiring resources significantly more often
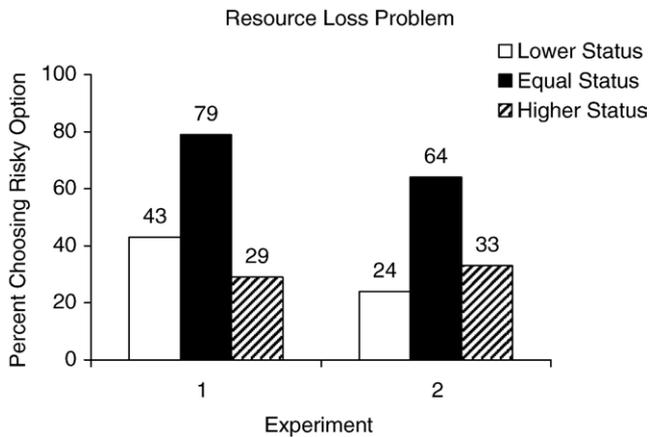
Fig. 1. Across both experiments, men chose the risky option on the resource loss decision problem more often when they were equal in social status than when they were relatively lower or higher in status.

than men who thought their own status was lower or higher than that of their evaluators (E>L: $z=1.93$, $p=.05$, $\varphi=.37$; E>H: $z=2.65$, $p=.008$, $\varphi=.50$). The proportions of men choosing the risky option in the lower and higher status conditions did not differ significantly from one another (L vs. H: $z=0.79$, $p=.43$, $\varphi=.15$).

We predicted that status effects in men would be domain specific, elicited by decisions relevant to male intrasexual competition. To control for domain and test for specificity, the same men also responded to a medical risk problem having nothing to do with intrasexual competition

When making decisions about a domain that is irrelevant to intrasexual competition, did men's relative status affect how often they chose the risky option? No. As predicted, relative status had no effect on how often men chose the risky option on the control problem, which involved medical treatments for preventing loss of life (L=64%, E=50%, H=57%; $\chi^2(2, n=42)=0.58$, $p=.75$, $\varphi=.12$).

Did women's relative status affect how often they chose risk? No. As predicted, social status did not significantly affect how often women chose the risky option on either problem (resource loss: L=35%, E=29%, H=33%; $\chi^2(2, n=52)=0.14$, $p=.93$, $\varphi=.05$; medical loss: L=53%, E=47%, H=39%; $\chi^2(2, n=52)=0.70$, $p=.70$, $\varphi=.12$).

These results underscore the importance of examining both the domain of risk and the social context in which risky decisions are made. When men believed other men would be observing and evaluating their decisions, their status relative to these "evaluators" regulated how willing they were to choose a high-risk/high-gain method of acquiring resources. As predicted, men's relative status affected their risky decision making only when the domain was relevant to male intrasexual competition: status effects were elicited by a chance to recover monetary resources, but not by decisions about risky medical treatments. The analysis of intrasexual competition in men that led to these predictions does not apply to women; as expected,

women's relative social status did not affect their choices on either problem.

The effects of status in men support dominance theory. Faced with a resource acquisition problem, men chose the risky option more often when they thought their decisions would be seen and evaluated by other men of equal status. Men were more risk averse when their status differed — in either direction — from that of their alleged evaluators. This pattern is exactly what one would expect if men's risky decisions were being generated by a motivational system that evolved to regulate dominance interactions: activating motivations for competitive risk taking can make a difference when one's choices are being observed and evaluated by a competitor of equal status, but this strategy is not advantageous when discrepancies in status are large.

The results of this experiment indicate that the investigation of the effects of social status on risky decision making is a fruitful line of inquiry. Experiment 2 was conducted to replicate these status effects with a larger sample in a different population and to explore social status effects on other types of risky decision problems.

3. Experiment 2

Experiment 2 was designed to answer two questions: (i) Will the results of Experiment 1 replicate in another population? (ii) Do the effects of status on men's motivations for risk change when problems involve gain rather than loss?

The prospect of loss loomed in both of Experiment 1's decision problems: choices might allow the subject to recover money that had already been lost (resource loss problem) or to prevent deaths from an otherwise fatal disease (medical loss problem). The best outcome was to merely break even, whether choices were framed positively (saving money; people living) or negatively (losing money; people dying). Other decision problems, however, can involve the possibility of achieving a net gain — of improving one's position rather than hoping (at best) to maintain it. Initial research on prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1981) showed that risky choice can be affected by (i) a problem's structure — that is, whether a situation holds the prospect of loss vs. gain, and (ii) its framing — holding structure constant, whether choices are described using the language of loss vs. gains. Problems with a loss structure were most often used in subsequent research on framing effects (Fagley, 1993; Fagley & Miller, 1997); evidence that a structure of loss vs. gain affects risky choice is mixed, with effects varying widely across problems (e.g., Harbaugh, Krause, & Vesterlund, 2002; Highhouse & Paese, 1996; Schneider, 1992; Xie & Wang, 2003).

The distinction between loss vs. gains (as opposed to framing effects alone) is an important one for understanding

risky decision making (Rode et al., 1999). Thus, Experiment 2 added two problems involving gains. Social status was not expected to affect men's risky choices on the medical gain problem. The resource gain problem, however, raises two theoretical possibilities, depending on whether or not the mind treats status competition as a distinct subdomain of risky decision making:

1. *Only aspiration matters*. The resource gain problem presents men with the opportunity to acquire culturally valued, status-relevant resources. If status effects are produced by decision rules designed to choose risk in pursuit of resources when this is likely to meet a status aspiration level (as on a risk-sensitive foraging account), resource gain problems should elicit status effects, just as resource loss problems do.
2. *Loss signals impending competition*. In many species, having been seen to lose a resource to another puts one at greater risk of being challenged (and possibly displaced) by a competitor, especially one close in rank (Wilson, Daly, & Gordon, 1998). This cue of impending competition — having just lost a resource to another — is present in the resource loss problem, which elicited status effects. In contrast, the resource gain problem describes a cooperative setting with an opportunity for gain; it completely lacks any cues of impending competition. If status effects are produced by a motivational system designed primarily for negotiating competitive interactions (as on a dominance theory account), cues of impending competition may be necessary to activate it. Because the resource gain problem lacks these cues, it should fail to activate a motivational system regulating competitive interactions and, therefore, fail to elicit status effects.

3.1. Method

3.1.1. Subjects

One hundred and ninety-five students (101 men, mean=18.5 years, S.D.=0.94) enrolled in an introductory psychology class at the University of California, Santa Barbara (UCSB) participated in this experiment for course credit.

3.1.2. Measures and experimental manipulations

3.1.2.1. Decision problems. Subjects completed six forced choice decision problems. Because framing effects were not of interest in this study, balanced frames were used in all problems, rather than using and counterbalancing both positive and negative frames, as in Experiment 1. In the balanced frame, each option stated the outcome in both positive and negative terms (see below). Two of the decision problems were balanced frame versions of the resource and medical loss problems used in Experiment 1. As both of these problems involved an overall loss, a matching version of each problem was created wherein the situation was an overall gain.

Resource gain problem (balanced frame):

Imagine that your company has had a relatively good year and decides to give some of its profits to its employees by offering games with monetary rewards. You are offered a choice of two gambles, with a maximum gain of $75.
If you choose Option A, you will win $25 and the company will keep $50.
If you choose Option B, you will take part in a random drawing procedure with exactly a one-third chance of winning $75 and a two-thirds chance of winning no money.
Which of the two options would you favor?

The medical gain problem was about choosing drug treatments to extend people's lives and was intended to be a content control for the resource gain problem, rather than an exact parallel to the medical loss problem. The two resource problems had either US$60 or US$75 at stake (counterbalanced across subjects), and the two medical problems had the lives of either 60 or 90 people at stake (also counterbalanced across subjects). Another two decision problems were created to explore the possible effects of differences of personal involvement between the resource and medical problems. This doubled the number of decision problems, and we did not know how long the effect of the status prime would last, given evidence that social primes do not last long when actual social agents are not present in the room (Ratcliff & McKoon, 1988). We therefore took steps to ensure that the key problems of interest (resource loss and gain) appeared in proximity to the status prime (Position 1 or 2) often enough that we would be able to analyze a set of data that had been collected in a manner methodologically comparable to that for Experiment 1.

The order of the problems was counterbalanced, subject to the constraint that no two resource problems or two medical problems occurred sequentially. In addition, the possible orders were constrained such that at least one of the key problems (resource loss or resource gain) was presented in one of the initial two positions (for comparability to Experiment 1). Eight different orders were used. The number of dollars and the number of lives at stake were counterbalanced across decision problems and across orders. In addition, the order of the options, i.e., whether the sure option or the risky option came first, was counterbalanced across decision problems and across orders.

3.1.2.2. Social status. Colleges for the (sham) evaluators were selected from two surveys of 106 (total) other UCSB students, who rated both the social status of a graduate from various colleges and universities and their familiarity with those schools on seven-point scales. On the basis of these ratings, three comparison colleges were chosen: Harvard University (status higher than UCSB), University of California, San Diego (UCSD) (status equal to UCSB), and Santa Barbara City College (SBCC) (status lower than

UCSB). Subjects were randomly assigned to one of three relative status conditions: subject's status lower (i.e., evaluators from higher status Harvard), equal (evaluators from equal status UCSD) or higher (evaluators from lower status SBCC).

All other aspects of the method were identical to Experiment 1, except that the entire experiment took place in one room.

3.2. Manipulation checks and preliminary analyses

3.2.1. Social status ratings

Subjects did in fact perceive graduates of the selected schools as differing in status in the intended directions. Subjects rated the social status of UCSB graduates (mean=5.5, S.D.=0.73) as significantly lower than that of Harvard graduates (mean=6.6, S.D.=0.95; $t(195)=-12.66$, $p<.001$, $r=.67$), significantly higher than that of SBCC graduates (mean=3.7, S.D.=1.14; $t(195)=23.76$, $p<.001$, $r=.86$) and as not significantly different from that of UCSD graduates (mean=5.6, S.D.=0.74; $t(194)=-1.35$, $p=.18$, $r=.10$).

3.2.2. Status prime manipulation — check on Problems 4–6

Where status effects were found, effect sizes were markedly greater for problems presented in the first three serial positions (resource loss: men, $\varphi=.35$; women, $\varphi=.37$) than for problems presented in the last three positions (men, $\varphi=.22$; women, $\varphi=.08$). Furthermore, a linear decrease in effect size was observed as data from subjects who received the problem in later positions were added to the analysis. Accordingly, the results reported below are only for subjects who received the problems of interest first, second or third. This third problem cut-off point was chosen for three reasons: (i) Experiment 1 used three problems, making this procedure directly comparable; (ii) Experiment 1 found status effects using three problems; and (iii) a page turn was necessary after the third problem in this study, providing a natural pause.

Results from the two new problems exploring effects of personal involvement are not presented because too few subjects received these problems in the initial positions to permit meaningful statistical analyses (but see Experiments 2A and 2B).

3.3. Results and discussion

The key results are shown in Fig. 1 and Table 1. As before, L, E and H (lower, equal, higher) refer to the subject's status relative to his or her sham evaluators.

3.3.1. Men's responses

For resource loss problems, were men's risky choices affected by their relative status? Yes. Replicating the findings of Experiment 1, relative status significantly affected how often men chose the risky option on the resource loss problem (L=24%, E=64%, H=33%: $\chi^2(2$, $n=64)=7.75$, $p=.02$, $\varphi=.35$). The overall effect size for

men's choices on the resource loss problem ($\varphi=.35$) was comparable in magnitude to the effect size found in Experiment 1 ($\varphi=.42$).

Again replicating Experiment 1, status had no effect on men's choices in response to the control (medical loss) problem (L=41%, E=65%, H=45%; $\chi^2(2, n=62)=2.73$, $p=.26$, $\varphi=.21$). As expected, status had no significant effect on men's choices on the medical gain problem either (L=50%, E= 46%, H=74%: $\chi^2(2, n=63)=4.24$, $p=.12$, $\varphi=.26$).

Dominance theory or risk-sensitive foraging theory? As Table 1 shows, planned comparisons supported dominance theory, replicating the pattern found in Experiment 1. In Experiment 2, men chose the risky option more frequently in the equal status condition than in the lower or higher status conditions (E>L: $z=2.63$, $p=.009$, $\varphi=.40$; E>H: $z=1.99$, $p=.05$, $\varphi=.30$). The proportions of men choosing the risky option in the lower and higher status conditions were low (22%, 33%) and did not differ significantly from one another (L vs. H: $z=0.68$, $p=.49$, $\varphi=.10$).

Having just lost resources to another is a cue of impending competition from those close in rank. Is this cue necessary to elicit status effects in men, or will a resource gain problem elicit the same pattern? The resource gain and loss problems both present men with the same opportunity to take risks to get resources. They differ only in how they characterize the man's position prior to his choice. In the gain problem, he starts out in a good position: he is working for a company that has had a good year and wants to share the profits with him. In the loss problem, he has lost resources that he invested in a now bankrupt company, and the company (and the evaluators) know it.

If the subject's status relative to his evaluators determines his aspiration level, and this variable is fed into domain-general decision rules regulating risk in pursuit of status-relevant resources, then the resource gain and loss problems should produce the same pattern of risk taking. They did not. Resource loss problems consistently produced status effects in men, but relative status had no effect on men's choices on the resource gain problem. Indeed, their choices in response to the gain problem hovered around 50%, reflecting indifference between the risky and sure options (L=55%, E=52%, H=48%: $\chi^2(2, n=62)=0.23$, $p=.89$, $\varphi=.06$). A follow-up experiment (2B), reported below, shows that the lack of status effects for men on resource gain problems is reliable.

The difference between loss and gain problems cannot be explained by prospect theory (Kahneman & Tversky, 1973). If losses loom larger than gains, then risk taking in each status condition should be higher for the resource loss problems compared to the resource gain ones. It was not: for the lower and higher status conditions, the resource loss problem elicited fewer risky choices than the resource gain problem.

The results are consistent with the view that for men, losing resources is a cue signaling an increased risk of being
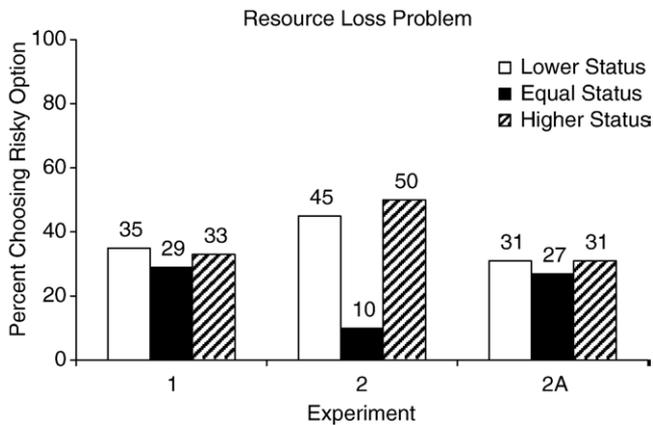
Resource Loss Problem

Fig. 2. Across experiments, relative social status had no consistent effect on women's choices on the resource loss decision problem.

challenged by a competitor close in rank. Men imagining a scenario in which they had just lost resources chose the risky option twice as often when they believed men close in rank were going to evaluate their choices, compared to conditions in which they believed their putative evaluators were distant in rank. In contrast, when men were imagining a cooperative situation with an opportunity for resource gain — a situation lacking cues of impending competition — they did not vary their risky choices as a function of their relative status. This difference between resource loss and gain problems is expected on the view that cues of impending competition are necessary to activate a motivational system regulating competitive inclinations, and it is this system that uses relative status to regulate men's risky decision making.

3.3.2. Women's responses

Were women's risky choices affected by their relative status? Yes. Although the resource loss problem elicited no status effects from women in Experiment 1 ($\varphi=.05$), the same problem did elicit status effects in Experiment 2 (L=45%, E=10%, H=50%: $\chi^2(2, n=60)=8.35$, $p=.02$, $\varphi=.37$; see Fig. 2).

In Experiment 2, the risky option was chosen by significantly fewer women in the equal status condition than in the lower (E<L: $z=-2.48$, $p=.01$, $\varphi=.39$) or higher status conditions (E<H: $z=-2.01$, $p=.006$, $\varphi=.44$), and the proportions of women in the lower and higher status conditions did not differ significantly from one another (L vs. H; $z=1.61$, $p=.75$, $\varphi=.05$). This pattern does not fit dominance theory, risk-sensitive foraging theory or the pattern produced by women in response to the same problem in Experiment 1. However, there was no case in which the results elicited by a status condition in Experiment 2 differed significantly from its matching condition in Experiment 1. The overall pattern differed because the lower and higher conditions in Experiment 2 were slightly higher than in Experiment 1 (p's>.25), and the equal condition was slightly lower ($p=.13$). Therefore a

follow-up experiment (2A) was conducted to see whether this result represents signal or noise.

Status did not significantly affect women's choices on the resource gain problem (L=61%, E=25%, H=35%: $\chi^2(2, n=58)=5.44$, $p=.07$, $\varphi=.31$). There was a marginal effect of status ($p=.07$), but the pattern did not fit dominance theory, risk-sensitive foraging theory or the pattern observed for women's choices on the resource loss problem (the only significant difference was between the lower and equal conditions: L>E: $z=-2.25$, $p=.02$, $\varphi=.37$; E vs. H: $z=0.69$, $p=.49$, $\varphi=.11$; L vs. H: $z=1.61$, $p=.11$, $\varphi=.26$). This pattern did not replicate in a follow-up experiment (2A), so it is not interpreted further.

As in Experiment 1, social status did not significantly affect women's choices on the medical problems, whether they were framed in terms of loss of life (L=63%, E=40%, H=42%: $\chi^2(2, n=58)=2.52$, $p=.28$, $\varphi=.21$) or gains in longevity (L=63%, E=50%, H=41%: $\chi^2(2, n=59)=2.03$, $p=.36$, $\varphi=.19$).

4. Follow-up experiments: 2A and 2B

Experiment 2A (women). Unlike Experiment 1, which had shown no status effects for women on the resource loss problem, Experiment 2 had produced status effects for the same problem, but in an unexpected pattern. To see whether that pattern was signal or noise, Experiment 2A tested women from the same population as Experiment 2 on the resource loss problem. Women in 2A were also given the resource gain problem, to see whether the marginally significant status effect elicited by that problem in Experiment 2 was replicable.

Experiment 2B (men). The goal of this follow-up was to see whether the lack of status effects for men on resource gain problems is a replicable phenomenon.

Personal involvement. In addition, both follow-up experiments addressed a possible interpretive confound in the medical control conditions of previous experiments. In prior experiments, the medical loss problem was used as a control to argue that status effects observed for resource loss were specific to a domain relevant to male intrasexual competition: resource acquisition. However, the resource loss and medical loss problems differed not only in content (monetary resources vs. medical treatments), but also with respect to the subject's (putative) personal involvement in the decision problem: the resource loss problem involved the subject's own money, but the medical loss problem involved the lives of anonymous others. Although the results on the resource gain problem from Experiment 2 show that personal involvement in the content of the decision problem is not, by itself, sufficient to produce status effects, the possibility remains that personal involvement in the loss domain would produce the same status effects, regardless of problem content. To control for this possibility, a variant of the medical loss problem where the lives at stake were the

subject's friends, rather than anonymous others, was included in both follow-ups.

4.1. Method, Experiment 2A (women)

4.1.1. Subjects

Seventy-eight women (mean=18.2 years, S.D.=0.99) enrolled in an introductory psychology class at UCSB received course credit for their participation in this experiment.

4.1.2. Decision problems

Subjects were given three problems: the resource loss and gain problems used in Experiment 2 and a medical loss problem identical to the one in Experiment 2 except that the lives at stake were the subject's friends rather than anonymous others. All other aspects of the method were the same as the previous experiment.

4.2. Results and discussion for 2A

Women showed no status effects to the resource loss problem in Experiment 1, but a significant (resource loss) and a marginal (resource gain) effect of relative status in Experiment 2, in unexpected (and dissimilar) patterns. Were these status effects replicable? No. Women in 2A showed no status effects in response to either resource problem (loss: L=31%, E=27%, H=31%; $\chi^2(2, n=78)=0.12, p=.94, \varphi=.04$; gain: L=35%, E=42%, H=31%; $\chi^2(2, n=78)=0.78, p=.67, \varphi=.10$).

As Fig. 2 shows, the responses of UCSB women to the resource loss problem in 2A were almost identical to those of F&M women in Experiment 1. In short, the unexpected resource loss pattern for UCSB women in Experiment 2 did not replicate, suggesting that it represented noise rather than a real difference between populations. Indeed, Fig. 2 reveals that the means for each status condition are similar across all three experiments.

Although the resource gain problem had elicited a marginal status effect in Experiment 2 (with risk chosen most often by women in the lower status condition), the same problem elicited no status effects at all in 2A.

Replicating the results for the medical loss problem with anonymous others in Experiments 1 and 2, it was found that relative status did not affect women's risky choices on the medical friends problem (L=62%, E=46%, H=69%: $\chi^2(2, n=78)=2.97, p=.23, \varphi=.20$).

4.3. Method, Experiment 2B (men)

4.3.1. Subjects

Seventy-four male students (mean=18.7, S.D.=0.95) enrolled in an Introductory Psychology class at UCSB received course credit for their participation in this experiment.

4.3.2. Decision problems

Subjects were given three problems, including the medical loss with friends problem used in Experiment 2A and a variant of the resource gain problem. A third problem was included to keep the method parallel, but results from that problem are not presented.

All other aspects of the method were the same as in the previous experiments.

4.4. Results and discussion for 2B

On loss problems, can men's personal involvement in the outcome explain the fact that resource loss, but not medical loss, elicited effects of relative status in Experiments 1 and 2? No. Men's relative status did not affect their choices on the medical treatment problem, even though the loss of friends' lives implies a high level of personal involvement (L=58%, E=56%, H=33%: $\chi^2(2, n=73)=3.68, p=.16, \varphi=.23$). This confirms the previous interpretation of Experiments 1 and 2: when resource loss, but not medical loss, elicited status effects, this was because the problems differed in content (resources vs. medical treatments), not because they differed in levels of personal involvement in the outcome.

When men have not just suffered a resource loss, does status affect their risky choices about resources? No. As in Experiment 2, the resource gain problem elicited no status effects (L=50%, E=44%, H=56%: $\chi^2(2, n=74)=0.72, p=.70, \varphi=.10$).

5. Conclusions

Many species have evolved a cue-activated motivational system that regulates an organism's willingness to take competitive risks. Activated by the presence of competitors for resources, these systems assess relative rank and generate responses that correspond to the evolutionarily stable strategies specified by dominance theory: higher risk taking when one is facing a competitor close in rank, lower risk taking otherwise (e.g., Archer, 1988). Our experiments support the hypothesis that a cue-activated motivational system designed by the same selection pressures inhabits the cognitive architecture of men.

By analyzing selection pressures relevant to intrasexual competition in men, we derived a series of predictions about the design features of this motivational system; all of these predictions were confirmed by the experiments reported herein. Men were led to believe that other men would be observing and evaluating their decision to choose between a high-risk/high-gain option and a no-risk/low-gain option. The status of the subject relative to his evaluators was varied across conditions: his status was either equal to, lower than, or higher than the status of the men who would be watching and evaluating him. When men were faced with a situation in which they had just lost resources and had an opportunity to recover them, relative status regulated their risky decision making, in a replicable pattern predicted by dominance theory. When their status was equal to that of their evaluators, most men chose the high-risk/high-gain option (79%, 64% in Experiments 1 and 2, respectively), but when their status was different from their evaluators — either higher or lower — they were less likely to choose risk in

both experiments (subject's status higher: 29%, 33%; subject's status lower: 43%, 24%). This result implicates a motivational system specialized for regulating dominance interactions, which has been extended in humans to regulate men's status interactions as well.

As predicted, the cues and conditions necessary for eliciting this dominance-theory pattern were strikingly domain specific, providing additional evidence that men's responses were regulated by a system specialized for negotiating dominance/status interactions. Men were influenced by status when the problem tapped a choice domain that was an arena of intrasexual competition (recovering lost resources), but not when it tapped a choice domain that was irrelevant to intrasexual competition (alternative medical treatments). Moreover, in contrast to the resource loss scenarios, resource gain scenarios did not elicit status effects, providing further evidence of special design. Across species, having been seen to lose a contested resource is a cue of impending competition from challengers close in rank; accordingly, imagining a situation in which one has first lost a resource elicited increased risk taking in men being evaluated by others close in rank. In contrast, the resource gain problems, which lacked this or any other cue of impending competition, produced no status effects.

As expected, this very precise pattern was found for men, not women. Women's status relative to their (same-sex) evaluators rarely had any effect on their risky decision making; in those few instances in which a significant effect was found, further experiments showed it was not replicable.

5.1. Evidence for the co-evolution of motivation and cognition

Motivation rarely plays a role in cognitive accounts of judgment and decision making. When it does, it usually takes the form of a utility curve or preference (but see Fessler, Pillsworth, & Flamson, 2004; Maner & Gerend, 2007). Risk-sensitive foraging theory is an example. It was developed to account for animal foraging, but its logic is general to all domains in which one must choose between two options. Whether an individual aspires to a specified level of calories, dollars, health, safety, status or anything else, that aspiration could, in principle, be fed into domain-general decision rules that consult the distributions associated with each option and select the one most likely to achieve that aspiration. Motivation enters the picture at only one point: in determining what good or state one wishes to achieve — one's aspiration. Consistent with the hypothesis that the human mind is equipped with risk-sensitive decision rules that take inputs from almost any domain, food is not necessary to elicit decisions from people that satisfy the constraints of risk-sensitive foraging theory: ball and urn tasks will do (Rode et al., 1999; see Barrett & Fiddick, 1999).

Yet the experiments reported herein suggest that these same decision rules were not activated by an aspiration for status. There were no cases in which the pattern of risk taking tracked the predictions of risk-sensitive foraging theory; moreover, resource gain scenarios failed to elicit status effects — they should have if the only motivational variable involved was an aspiration for resources or status. It is as if risk-sensitive decision rules were pre-empted by the activation of a more specialized system: a cue-activated system designed to regulate men's motivations to take competitive risks in dominance/status interactions (see Fiddick, Cosmides & Tooby, 2000, on the principle of pre-emptive specificity).

This account turns the relationship between motivation and cognition on its head. Rather than aspirations, desires and other motivational variables serving as inputs to domain-general decision rules, we are proposing that men's responses were produced by a motivational system specialized for regulating competitive interactions, which is equipped with its own, proprietary decision rules. Faced with a potential competitor, this system computes a status index: an internal regulatory variable whose magnitude reflects the individual's status relative to the competitor (Tooby, Cosmides, Sell, Lieberman, & Sznycer, in press). Decision rules proprietary to the motivational system — ones that are dormant until the system has been activated — use the status index, the computed value of the resource, and other variables to up- and down-regulate one's motivation to take competitive risks. By hypothesis, these specialized decision rules were not designed to meet an aspiration level for money, status or anything else. Their evolved function is regulatory: to produce levels of risk-taking behavior that would have been adaptive in ancestral situations of resource competition.

The results suggest that this motivational system, like other evolved systems, is cue activated (Barrett, 2005; Cosmides & Tooby, 2000; Haley & Fessler, 2005; Sperber, 1994). It comes online when there are ancestrally reliable cues of impending resource competition. In these experiments, men had not actually lost resources to others; they were merely imagining that situation. Yet believing that other men would be watching and evaluating their decisions — decisions that would reveal how much risk they would be willing to take to recover resources they had lost — was sufficient to elicit dominance theory's inverted U-shaped pattern of risk taking in response to relative status. Men imagining resource loss behaved as if their evaluators were — or would soon become — competitors in a zero-sum contest for resources. The task may have been paper-and-pencil with no actual money at stake and the loss may have been imaginary, but relative status regulated men's motivation for risk nevertheless.

When judged by the standards of mathematics or economics, men's risky decision making in these experiments may seem irrational, but their choices did conform to a normative theory: the evolutionary logic of dominance interactions. This normative theory is rooted in the average fitness payoffs associated with alternative courses of action in the intimate social world of our ancestors. Results

reported here illustrate how the principles governing judgment under uncertainty can be both well engineered, yet different across different adaptive problem domains. Indeed, these findings suggest that motivational domains trigger qualitatively different cognitive procedures, undermining the traditional assumption that the only role of motivation is to generate preferences.

Acknowledgments

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