Risk Communication and Risky Choice in Context

Ambiguity and Ambivalence Hypothesis

XIAO-TIAN WANG

Psychology Department, University of South Dakota, Vermillion, South Dakota, USA

This chapter takes a synthetic approach to six related lines of research on decision making at risk and views risky choice as a function of cue use with priorities in the context of risk communication. An evolutionary analysis of risk and risk communication is presented in which risk is defined not only as variance in monetary payoff but also as variance in biological relatedness, social relations, and ultimately in reproductive fitness. Empirical evidence of ecological and social significance embedded in risk messages is analyzed, and how these risk cues affect behavioral decision making is examined. A new explanatory framework, the ambiguity and ambivalence hypothesis, identifies two key preconditions contributing to inconsistency and biases in making risky choices as a result of cue use in the course of risk communication.

Key words: **biases; decision cues; evolutionary psychology; risk communication; risk perception; risky choice**

Bounded Rationality and Cue Priority

When we make decisions, to what extent are the decisions influenced by ecological and social cues as opposed to expected values of normative utility models and probability theory? How do we intuitively organize and utilize decision cues as indicators of our values and morality? To explore these questions, I take a synthetic approach to six related lines of research.

First, according to Brunswik,[1] cues used in decision making are vicarious predictors of a target variable. These vicarious cues are not equally reliable in different task environments and thus are selected with priority and substituted for each other. Individual decision cues are incomplete predictors of uncertain outcomes but collectively sufficient for making accurate judgments and decisions.

Second, Simon's notion of bounded rationality suggests that the search for decision cues in real life is not unlimited and thus cannot be exhaustive.[2,3] To survive and thrive in the face of risks and uncertainties under time constraints, one is obliged to settle for less than the optimal. Simon identified two interlocking components of bounded rationality: the limitations of the mind and the structure of the environments in which the mind operates. In his own words, "Human rational behavior is shaped by a scissors whose blades are the structure of task environments and the computational capabilities of the actor" (p. 7).[3]

Third, recent development in the fast and frugal heuristics program combines the Brunswikian tradition of vicarious functioning and Simon's bounded rationality and satisficing (i.e., satisfying and sufficing as opposed to optimizing) heuristics. Studies by Gigerenzer *et al.*[4] suggest that fast and frugal heuristics can be viewed as a set of task-dependent mental tools that use little information and computation to make decisions. The studies on simple step-by-step heuristics of human judgment and decision making demonstrate that decision makers use decision cues that are prioritized according to their ecological validity in a specific task environment.

Fourth, the heuristics and biases program developed by Kahneman, Tversky, and others has focused on cognitive limitations of decision agents (the first component of bounded rationality) and has identified a list of judgmental errors and decision biases by manipulating the informational structure or context of a decision problem without altering the incentive structure.[5–7] This line of research provides a common platform for further testing of mechanisms underlying these judgmental errors and decision biases.

Fifth, the last three decades have witnessed interdisciplinary developments in the studies of regulating

Address for correspondence: X.T. Wang, Ph.D., Professor of Psychology, University of South, Dakota, Vermillion, SD 57069. Voice: +605-677-5183 (O).
xtwang@usd.edu
http://www.usd.edu/~xtwang

Ann. N.Y. Acad. Sci. 1128: 78–89 (2008).
doi: 10.1196/annals.1399.009

effects of reference points in risk perception and risky choice. Behavioral studies of human decision making have mostly focused on the effects of the status quo reference point and have shown that it is possible to manipulate the reference point of a decision maker to systematically affect choice behavior.[5,6,8] The studies in management science focus on how goa settings affect risky choice and task performance.[9–12] The studies of risk-sensitive foraging have drawn research attention to another important decision reference point: minimum requirement of a task.[13,14] The analysis of minimum requirement effects was also used in studies of human decision making.[15,16] To make adaptive decisions at risk and under task constraints, people are bound to maximize the likelihood of reaching a goal and minimize the likelihood of falling below a minimum requirement at the same time.[12]

Sixth, recent developments in evolutionary cognitive psychology have provided a framework for identifying and prioritizing important decision cues in risk communication and risky choice.[17–19]

In the following two sections, I elaborate on some insights gained from these six lines of research and on the behavioral implications of the present synthesis.

Normative, Bounded, and Social Rationalities

In contrast to a normative and unbounded rationality, Simon argues that humans "must use approximate methods to handle most tasks" (p. 6).[3] This means that information search should include heuristics that largely obviate redundancy and that determine when searching should end, as well as simple decision rules that effectively make use of the valid information available. Over the last several decades, we have gained a great deal of knowledge about how human judgment and decision making have been adjusted to, or biased by, our limited computational capacities.[5–7] However, we have learned relatively little about how the structure of task environments has shaped our decision rationality. This second component of Simon's bounded rationality has been largely ignored in contemporary studies of human judgment and decision making.

Recently, however, important developments have taken place in exploring how decision mechanisms are adaptively matched to the informational structures of the environments in which decisions are made. Gigerenzer *et al*. made a compelling case for using simple heuristics in probability judgment and decision making under uncertainty.[4] The central argument for the simple heuristics approach is that the environments in which we evolved and in which we now live have certain regularities or cues, and decision-making mechanisms make use of these environmental cues.

A growing body of evidence shows that humans do indeed make decisions in an ecologically rational manner, using as little information as possible, and tailoring their information and option search to the structures available in the environment. It has been found that simple heuristics that use only a single piece of information (one cue) to make a choice between two alternatives can usually rival the performance of information-hungry normative methods, such as multiple regression and Bayesian analysis.[20] People often make their decisions according to holistic feelings instead of rational analysis.[21] Experts have been also shown to base their judgments on surprisingly few pieces of information.[22]

Parsimonious cue use in decision making suggests that cues are selected and used with priority. I argue that the priorities of primary cues are originally determined by their evolutionary and ecological validities. Humans have evolved in natural environments, both social and physical. To survive and reproduce successfully, humans have to adapt to and make use of the reliable cues often present in these environments.

From a perspective of evolutionary psychology, human rationality has been shaped by natural selection and sexual selection in the environment of evolutionary adaptedness (EEA). The recurrent and enduring tasks in EEA (i.e., hunter–gatherer's environments) are viewed as universal contexts for the making of human psychology. These specific adaptations are evaluated not in terms of logical consistency or happiness of the human being but in terms of survival and reproductive fitness.[22–24] From this perspective, primary and prioritized decision cues should be able to accurately reflect evolutionary and ecological values of risks. The risk in this sense is measured not only by the variations in monetary payoffs but also by the variations in ecological environments, in the reproductive status of the decision maker, and in the genetic relatedness between a decision maker and different decision recipients.

Variation in kinship thus can be seen as a defining feature of risk in terms of reproductive consequences. Decision cues concerning kinship would be prioritized as primary cues in human decision processes. As pointed out by Burnstein regarding kinship, "no human relationship is more precise, enduring, and inescapable. Nor is there a more intimate and taxing relationship, asides from those to create additional kin. Yet, the behaviorist orthodoxy, particularly its unbending commitment to learning, . . . assumed there is nothing inherent to genetic relatedness that precludes

unrelated individuals from developing equally close and demanding ties" (p. 528).[25]

W.D. Hamilton's formulation of inclusive fitness (or kin selection theory) offers a coherent explanation of social rationality inexplicable within the normative framework.[26] Hamilton's rule shashi ($C \leq rB$) shows that an "altruistic design" can spread through the population if it causes an individual to help a kin member whenever the cost (C) to the helper's own reproduction is offset by the benefit (B) to the recipient's reproduction, weighted by the genetic relatedness between the two (r). Hamilton's rule implies a relationship-bounded rationality for decision making at risk.

Trivers's analysis shows that helping behavior could also evolve between genetically unrelated individuals if (a) the benefit of the act to the recipient was greater than its cost to the helper, (b) there were sufficient opportunities for help to be reciprocated, and (c) cheaters (individuals accepting but not giving help) could be identified and discriminated against in social interactions.[27] Trivers called such a mechanism underlying social behavior, *reciprocal altruism*. Coupled with the inclusive fitness or kin selection theory of Hamilton, this analysis connects kinship-based decision rationality to friendship-based rationality, thus, a *kith-and-kin* rationality.

One obvious implication of a kith-and-kin rationality is that cues about genetic relatedness should spontaneously prime an impulse to behave altruistically. Burnstein *et al*. presented respondents with sets of two or three people and required them to choose from each set the one they would most likely help.[28] In both their Japanese and American samples, the likelihood of receiving help increased with genetic relatedness. More importantly, the rate of increase is greater under a life or death scenario than under an ordinary favor scenario. This second finding suggests that kith-and-kin rationality is more sensitive to the social situations of "true risk" where lives of kin are at stake. In addition, differences in risky situations activate different decision strategies. For instance, when help is a matter of life or death, altruists do not discriminate between rich and poor kin, but they do between rich and poor distant kin; that is, rich siblings are helped as often as poor ones, but rich cousins are helped more often than poor ones.

Similarly, Wang found that cues indicating reproductive values significantly affected risk preference of the respondents. When asked whether they would prefer a medical treatment that guaranteed saving the two youngest or the two oldest of six family members (sure option) or one that would cure all six members with a one-third probability, the young respondents (averaged 20.3 years of age) were equally risk taking regardless of whether this would save young or old relatives; but older respondents (averaged 41.4 years of age) were significantly more likely to choose the sure option if younger members of the family benefited (see FIG. 1).[29]

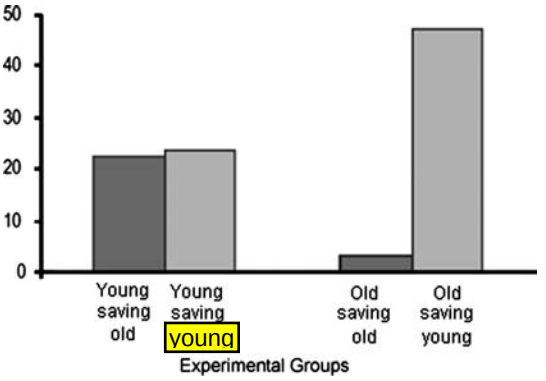

FIGURE 1. Age-dependent reproductive) values and risky choice (adopted from Wang[44]).

This finding is consistent with the evolutionary prediction that the phrases of saving "young" or "old" presented in the life–death problem would be perceived by the respondents as a primary cue indicating reproductive values of decision recipients when evaluated against the respondent's own age. This age cue about the hypothetical decision recipients (older versus younger kin) would then be used to gauge inclusive fitness of alternative choice options. Inclusive fitness of individuals who are themselves middle aged is unlikely to be enhanced by the activity of relatives who are even older, whereas their younger relatives would be expected to contribute quite substantially to their inclusive fitness since these individuals have most of their reproductive lives ahead of them. Young respondents, on the other hand, can expect their inclusive fitness to be enhanced by all their relatives at that particular stage in their lives, and they need show no differential preference for one generation over the other. These patterns have also been observed in people's actual behavior. Essock-Vitale and McGuire, for example, found that investment tended to flow from older to younger kin in their study of 300 Los Angeles women.[30]

This choice strategy using own age as a reference point can be turned off by presenting the life–death problem with one simple manipulation, the kind that would be seen as an ornament of an otherwise formally identical problem. When the hypothetical kin at risk were described as X's relatives, the respondents, although overall more prone to risk taking,

showed a preference for the "saving young" sure option over the "saving old" sure option.[29] In a third-person perspective, the respondents would not use their own age as a reference point and thus would be likely to consider "younger" survivors as youth and "older" survivors as senile people and place higher values on the saving young than the saving old option. In a situation where no true kith-and-kin relationships are involved, people would be more likely to resort to social norms applicable to the general population. This effect of perspective change suggests a design feature of kith-and-kin rationality. That is, it is a self-referenced mechanism that distinguishes real kinship relations from pseudo kinship relations. In the latter case, people tend to conform to social norms that tend to be need based rather than fitness based and thus place a higher value on lives of young members compared to elderly members of the society.

From No Reference Point to Single-reference Point to Tri-reference Points

At the heart of expected utility theory and many contemporary models of decision making has been the idea that decision makers aim to maximize their expected utility. The classic work by von Neumann and Morgenstern showed that the idea of expected utility maximization is derivable from a small set of axioms of behavioral consistencies in risky choice behavior.[31] These axioms appeared so reasonable and parsimonious that they have been used widely to define rational decision making. However, one common limitation of these normative models of decision making is their lack of consideration of the variance in expected outcomes. The use of a single value (the expected value) for each choice option is done at the cost of valuable information about payoff distributions in each of the choice options.

The importance of payoff variance and distribution for decision making lies in the fact that, under risk, one must consider not only those options which have the highest mean expected value but also the positive and negative variations from the mean expected value. Payoff variance has been a multidisciplinary concept. For example, variance in reproductive payoffs has been pivotal in some recent evolutionary analyses of human behavior.[32] The evolutionary logic for risk/variance sensitive strategies is that selection would favor greater risk proneness when risk avoidance promises not fitness but reproductive failure. Foraging bees and birds demonstrate an astonishing ability to detect and adapt to the variation in available resources.[33,34] In the field of economics or finance, following the pioneering work by Markowitz, risk is primarily measured by variance in expected monetary returns.[35] Similarly, in the literature of management, risk is also commonly conceived as variation in the value distribution of possible outcomes.[36,37]

In order to evaluate different kinds of variations in expected outcomes, reference points become necessary in risk assessment. In this context, a reference point is any value subjectively selected and used by an agent for the purposes of comparison, classification, and evaluation of possible outcomes associated with a decision. We propose the following five criteria for reference point selection. The reference points built in a model of risk perception and risky choice should: (1) be theoretically and practically present in most choice tasks; (2) affect choice preference, as supported by abundant empirical evidence; (3) reflect specific requirements rather than general desires, ambitions, or wishes; and (4) be parsimonious and sufficient to account for a large range of decision phenomena and biases. Also, (5) decision outcomes that cross over these reference points should have a greater psychological impact than the same amount of change between two reference points, producing nonlinear value functions.[38–40]

Based on the above selection criteria, we emphasize three reference points: goal, status quo, and minimum requirement. The three reference points demarcate the outcome space into four functional regions: success (reaching a goal), gain (improvement from the status quo), loss (deterioration from the status quo), and failure (falling below the minimum requirement). These reference points partition risks according to the distribution of choice outcomes and assign meaning and values to different parts of the payoff distribution. We assume from an evolutionary viewpoint that minimum requirement related to survival would be given a higher priority than goal, which is related to reproductive success and more flexible than the minimum requirement for survival. Following this reasoning, cues used in risk communication can be classified into minimum requirement-related cues and goal-related cues. The priority would be given to the cues indicating minimum requirement-related status in situations where outcome distributions of decision options are spread over different reference points.

In the following discussion, I put forth an ambiguity and ambivalence hypothesis in an attempt to synthesize the aforementioned notions of kith-and-kin rationality, reference-point-based decision making and cue use with priorities within a framework of risk communication. The hypothesis identifies two key preconditions contributing to inconsistency and biases in

making risky choices as a result of reactions to decision cues presented in the course of risk communication. I then report some empirical evidence supporting the predictions derived from the ambiguity and ambivalence hypothesis.

The Ambiguity and Ambivalence Hypothesis and Empirical Examinations

Based on a synthetic analysis of the aforementioned six lines of research on risk, risk perception, and risky choice, the ambiguity and ambivalence hypothesis proposes the following assumptions: (1) Decision cues are selected and used in accordance to their priorities. (2) *Cue priority* reflects evolutionary and ecological validity of a cue in predicting specific risks. (3) *Primary cues* in risk communication carry evolutionary, ecological, and social significance and anchor decision reference points, while *secondary cues* of verbal communication fine tune the settings of reference points. (4) Inconsistent decision biases tend to occur as a result of secondary cue use when primary cues are absent in risk communication (i.e., an *ambiguity* condition) or when primary cues elicit conflicting preferences (i.e., an *ambivalence* condition).

Consider the following two choice options: (A) a bonus trip to Paris versus (B) the same bonus trip to Paris plus a $5 coupon for a tour book about Paris. Suppose all of the respondents choose Option B. Can we thus conclude that the preference for Option B is rather strong, indicating that Option B has a much higher utility value than A? Not necessarily. The choice preference for Option B is clearly a result of the $5 coupon, which can be argued is a rather small incentive when it stands alone. This example illustrates that a minor or secondary factor can systematically swing choice preference when no better criteria or cues are available.

In the following sections, I use a well-known decision phenomenon, *framing effects*, to demonstrate how secondary verbal cues presented in a message may or may not shift the risky choice of a receiver or decision maker, depending on the ecological and social content and context of a risk problem. The term *framing* in this chapter refers to logically or mathematically identical ways of presenting, phrasing, or framing a choice problem (for discussions on typology of framing effects, see meta-analyses by Kühberger[41,42] and Levin *et al.*[43]). In the current analysis, verbal framing is used as an example of a secondary cue and as an experimental probe to examine the ambiguity and ambivalence hypothesis.

Ambiguity Effects in Risk Communication

Group Size Effects

Based on the ambiguity and ambivalence hypothesis, an ambiguity effect may occur when the social context of a risk problem is evolutionarily novel and thus has a low ecological validity. This lack of ecologically valid cues in decision context would result in ambiguity in risk preference, which in turn causes inconsistency and biases in risky choice.

A widely cited example of decision bias and human irrationality is a framing effect, first demonstrated by Tversky and Kahneman using the "Asian disease problem."[8] In the cover story of the problem, the participants were asked to imagine that "the US is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed." The outcomes of the programs were then framed (phrased) differently. In the "*positive framing*," the participants were told, "if Plan A is adopted, 200 people will be saved. If Plan B is adopted, there is a one-third probability that all 600 people will be saved and two-thirds probability that none of them will be saved." Given a binary choice between the two alternative plans, the majority of the participants (72%) were risk averse, preferring the *sure option* (Plan A) over its risky *gamble* equivalent (Plan B). However, when the same outcomes were "*negatively framed*" in terms of lives lost ("If Plan A is adopted, 400 people will die. If Plan B is adopted, there is a one-third probability that none of them will die, and two-thirds probability that all 600 people will die."), the majority of the participants (78%) were risk taking; they favored the gamble over the sure option.

This framing effect is considered to be a cognitive illusion because it violates the invariance axiom of expected utility theory, which requires a rational decision maker to have a consistent preference order among identical choice prospects independent of the way the prospects are presented or framed. What causes this irrational reversal in risk preference? Would the size of the group of individuals at risk play any role in the observed framing effect? In the original Asian disease problem, Tversky and Kahneman[8] did not identify the 600 people whose lives were at stake. What would happen if the number of lives at risk was not 600 but 6000 or six?

The size of a social group in question may serve as a useful and parsimonious cue of structural and relational features of the group. The size of a group may prompt the social relationships between the members in the group, their degree of interdependence,

TABLE 1. Group size effects in making risky choice regarding human lives: percentages of the participants choosing the gamble option

	American sample 1 (from Wang[44])			
	Group size = 6000	Group size = 600	Group size = 60	Group size = 6
Positive frame	40.9% ($n = 44$)	40.0% ($n = 50$)	67.5% ($n = 40$)	64.0% ($n = 50$)
Negative frame	61.4% ($n = 44$)	68.0% ($n = 50$)	65.0% ($n = 40$)	70.0% ($n = 50$)
Framing effects	Yes	Yes	No	No
	American sample 2			
	Group Size = 6000	Group Size = 600	Group Size = 60	Group Size = 6
Positive Frame	38.7% ($n = 31$)	41.9% ($n = 31$)	57.6% ($n = 33$)	66.7% ($n = 30$)
Negative Frame	66.7% ($n = 30$)	76.5% ($n = 34$)	66.7% ($n = 30$)	75.8% ($n = 33$)
Framing Effects	Yes	Yes	No	No
	Belgian sample (from Wang *et al.*[45])			
	Group Size = 6 billion	Group Size = 6		
Positive frame	36.0% ($n = 50$)	70.0% ($n = 50$)		
Negative frame	66.0% ($n = 50$)	70.0% ($n = 50$)		
Framing effects	Yes	No		

investment patterns, risk-management styles, dominance and affiliation hierarchies, relations with other groups, and common contracts endorsed in social exchange and reciprocal transactions. The implicit knowledge prompted by the group-size cue should then influence the risk perception and risk preference of a respondent.

In a series of studies,[15,44,45] we examined the appearance and disappearance of framing effects when the size of the group (the total number of lives at stake) was systematically manipulated. The same life–death problem was framed either in terms of lives saved or in terms of lives lost. The size of the group ranged from 6, 60, 600, 6000, to 6 billion. Each participant received only one version of the life–death problem.

We hypothesized an evolved *kith-and-kin* rationality attuned to ecological and social cues that were typical of EEA, such as group relational structure and group size. Human computational strategies are designed to process a collection of individuals in social situations as a "true group" using these cues. A "true group" is featured by either a kith-and-kin relationship or by a small size ranging from several (family or friends) to 100 or so (e.g., a band or tribe). Once a collection exceeds this size, choice strategies of individuals would deviate from a *live-or-die-together* principle to more self-interest-based game strategies.

Group size effects found in these experiments are summarized in TABLE 1. The results have consistently shown how framing effects wax and wane in response to changing size of the target group. The framing effect (i.e., the irrational reversal in risk preference) was evident, but it occurred only when the problem was presented in a large, anonymous, and thus ambiguous group context involving 600 lives or more.

The framing effect was absent when the size of the endangered group was within a two-digit number, and the majority of the participants unambiguously preferred the gamble option under both the saving and losing lives framing conditions. These results suggest that the small size of a social group signals a higher interdependence between group members and evokes a kith-and-kin rationality. Guided by this rationality, respondents showed a live-or-die together risk preference. In contrast, risk preference of a decision maker becomes erratic when prioritized group cues are absent in a large, anonymous, group context. When risk preference is ambiguous, secondary cues, such as verbal framing, are used to direct choices.

Disambiguating Effects of Experience: A Novice and Expert Comparison

Another way of examining ambiguity effects leading to decision biases is to examine whether framing effects can be reduced or eliminated by experience gained in coping with similar risks. In other words, experience would allow a decision maker to rely on relevant cues retrieved from memory and to be less dependent upon cues of verbal framing.

In a study of managerial decision making at risk,[46] we presented managerial scenarios to first-year Chinese students at a business school in Hong Kong and senior executives from a variety of industries recruited from executive MBA courses. The scenarios involved a joint-venture case and a lawsuit case (adapted from MacCrimmon and Wehrung[47] and Highhouse and

TABLE 2. Managerial experience blocks framing effects in managerial decision making

Participant	Scenario	Choice of the gamble option		Framing effect
		Threat frame	Opportunity frame	
Student	Joint venture	15/42 = 35.7%	31/42 = 73.8%	Yes
Student	Lawsuit	17/42 = 40.5%	41/46 = 89.1%	Yes
Executive	Joint venture	11/34 = 32.4%	5/29 = 17.2%	No
Executive	Lawsuit	11/33 = 33.3%	13/31 = 41.9%	No

Note that numbers in each cell represent choice frequency and percentage, respectively. For instance, 14/42 = 35.5% shows that 14 out of 42 or 35.5 percent of participants under the threat frame chose the gamble option.

Yüce[48]). For both the lawsuit scenario and the joint-venture scenario, there was a positive opportunity-framing version and a negative threat-framing version.

The joint-venture scenario asked the respondent to choose between a joint-venture with another company and competition with the same company for market share. Under the positive opportunity framing, the respondent was informed that "our chance of getting a large market share is high. We have a one in three chance of getting a large market share." Under the negative framing, the same assessment was communicated in terms of threats and the chance of failure: "Our chance of getting a small market share is high. We have a two in three chance of getting a small market share."

The lawsuit scenario started with a cover story that Company A has threatened to sue the respondent's company for patent violation. The case has not yet been filed in court since Company A is waiting to hear response to their offer to settle out of court. They have proposed a one-time cash payment for the claimed patent violation. If the respondent's company does not agree to this proposal, Company A will file a lawsuit. If the respondent's company loses in court, the company will incur significantly higher damage reparation. On the other hand, if the respondent's company wins in court, it will not need to pay anything.

Under the positive (opportunity) framing, the respondent was informed that "our corporate lawyer estimates that we have a one in three chance of winning the case." Under the negative (threat) framing, a respondent was told, "our corporate lawyer estimates that we have a two in three chance of losing the case."

In accordance with a two (scenarios) by two (framings) between-subjects design, the participants were randomly assigned to each of the four experimental conditions. The participants were asked to imagine themselves in the role of a newly appointed vice president of a large company who must make the decision alone, given the information available. The decision in both scenarios was between a sure option (joint venture in the first and settlement out of court in the second) and a gamble option (competition in the first and lawsuit in the second).

The results of risky choice of the student respondents and the executive respondents are shown in TABLE 2.

In support of the prediction derived from the ambiguity and ambivalence hypothesis, the framing manipulation significantly affected the choice of the novice respondents (students). Their choices were erratic because of framing manipulations. They were risk averse under the threat framing (35.7% and 40.5% respondents chose the gamble option in the joint-venture and lawsuit situations, respectively) but reversed their risk preference and became risk seeking under the opportunity framing (73.8% and 89.1% respondents chose the gamble option in the joint-venture and lawsuit situations, respectively). In contrast, no framing effect was found for the senior executives. The executive respondents were consistent across framing conditions, showing an overall risk-averse preference in both conditions. Organizational learning experience disambiguates the risk problems and immunizes the executives from manipulative effects of verbal framing.

Ambivalence Effects in Risk Communication

Conflicts in Social Strategies and Framing Effects

I now present empirical tests for ambivalence effects based on the ambiguity and ambivalence hypothesis. It is predicted that decision biases, such as framing effects, tend to occur when primary cues in risk communication simultaneously elicit incongruent or ambivalent preferences. Such ambivalence in preference would entail the use of secondary cues embedded in a risk message as a sort of a tie breaker. As Simon once pointed out, "Conflict of choice may often be equivalent to an absence of a choice mechanism in the given situation" (p. 137).[2] Thus, ambiguity and ambivalence in choice preference tend to have the same behavioral effects.

I first report an earlier study by Wang *et al*. to demonstrate how cues and information about social group composition could elicit multiple incongruent choice preferences (e.g., risk-seeking preference to save kin versus risk-averse or less risk-seeking preference for anonymous individuals in a small group) and, as a result, make the decision makers susceptible to framing manipulations.[45]

From the perspective of reference-point-dependent decision making, people are likely to be risk/variance seeking when the expected mean value of choice outcomes is below a task-relevant minimum requirement but become risk/variance averse to avoid possible disastrous outcomes when the expected mean value is above the task-relevant minimum requirement.[16,40] Previous studies suggest that the minimum requirement for the majority of participants in kinship group contexts is to save no less than two-thirds of the hypothetical family members at risk. The minimum requirement for saving lives in a small group context, however, is estimated to be lower and ranges between one-third and two-thirds of sure survival of the group members.[15,16]

According to the above analysis, we predicted that as the proportion of kin members in a hypothetical group increases, the minimum required survival rate increases.[45] Because of this increased minimum requirement, the sure outcome of saving one-third of the group members would fall below the minimum requirement in a homogenous kinship group context. Once the mean expected value of the sure outcome is below the minimum requirement, the only way to satisfy the minimum requirement is to resort to the high variance (gamble) option. People would be unambiguously risk seeking, irrespective of the secondary framing cue, as long as the homogeneity of kinship reaches a threshold (e.g., half or more of the group members are kin). In contrast, when group composition is a mix of kin and strangers, kinship homogeneity is low and the risk preference of a decision maker may experience a collision between a risk strategy adapted to make decisions regarding kin and a risk strategy adapted for coping with problems involving anonymous individuals. As a result of this ambivalence in risk preference, framing effects may occur because secondary cues must be consulted to make a decision.

To test this ambivalence-induced framing effect, we manipulated the hypothetical group composition. A life–death problem was presented in five different group contexts, all involving six individuals at risk: six kin, three kin, and three strangers, two kin and four strangers, one kin and five strangers, and six strangers. The second manipulation was the framing of the choice outcomes in terms of either survival or mortality. Using a between-subjects design, participants were assigned to one of the 10 (five group compositions and two framing conditions) experimental groups. Each participant responded to only one version of the life–death problem. The following paragraph exemplifies the scenarios used in the study. Note that items in parentheses represent the corresponding phrases used for the different experimental groups.

Imagine that (*six people/six people including one of your parents/six people including both your parents/six people including your parents and one of your brothers or sisters/six members of your family including your parents, brothers, and sisters*) are infected by a fatal disease.

The choice options under the two framing conditions were the same as described in the Asian disease problem. The participants were instructed to read the problem (written in French) and then to indicate their preferred choice option, either the sure outcome (Plan A) or the gamble (Plan B) of the same expected value.

TABLE 3 shows the result of this study.

Consistent with our predictions, no framing effects occurred in the homogeneous group situations where six kin or no kin (six strangers) were involved. The risk preference for kin was more risk seeking than that for strangers. The choice pattern of the "three kin and three strangers" situation resembled that of the kinship situation, suggesting that the participants treated the group as a kin group. The important and interesting finding concerning the ambivalence hypothesis is that framing effects occurred only in two mixed group situations when it was difficult to classify the groups as either a kin group or stranger group. We explain this phenomenon as an ambivalence effect due to incongruent risk preferences elicited by the mixed group composition (i.e., risk preference for kin versus risk preference for anonymous individuals). In such a situation, the respondents would be likely to look for other cues, such as framing of the choice outcomes to settle their ambivalent risk preference.

Conflicts between Emotional and Rational Preferences and Framing Effects

More direct and compelling evidence of ambivalence effects resulting from conflicting risk preferences comes from one of my recent studies.[49] One type of conflict that often significantly affects risk perception and risky decisions is the conflict between emotional reactions to and cognitive (rational) analysis of risk. Because of different determinants, emotional reactions to risks can diverge from cognitive evaluations of the same risks. Behavior is then determined by the interplay

TABLE 3. Choice frequencies and percentages for experimental groups in Experiment 1

Experimental group	Choice			
	Sure option	Gamble	Sample size	Framing effect
6 Kin-positive framing	15 (30%)	35 (70%)	50	
6 Kin-positive framing	15 (30%)	35 (70%)	50	No
3 Kin-positive framing	17 (34%)	33 (66%)	50	
3 Kin-negative framing	14 (28%)	36 (72%)	50	No
2 Kin-positive framing	26 (52%)	24 (48%)	50	
2 Kin-negative framing	13 (26%)	37 (74%)	50	Yes
1 Kin-positive framing	28 (56%)	22 (44%)	50	
1 Kin-positive framing	12 (24%)	38 (76%)	50	Yes
0 Kin-positive framing	22 (44%)	28 (56%)	50	
0 Kin-negative framing	20 (40%)	30 (60%)	50	No

Adopted from Wang *et al.*[45]

Note that the sample size for each of the 10 groups is 50.

TABLE 4. Framing effects as a result of conflicting emotional and rational preferences

	Natural disease problem Respondents choosing the risk-seeking gamble option			
	Decisive respondents		*Ambivalent respondents*	
Positive framing	57.1% (16/28)	No Framing Effect	36.4% (12/33)	Framing Effect
Negative framing	67.9% (19/28)	$\chi^2 = 0.686$; $P < 0.408$	68.4% (26/38)	$\chi^2 = 7.30$; $P < 0.007$
	Terrorist disease problem Respondents choosing the risk-seeking gamble option			
	Decisive respondents		*Ambivalent respondents*	
Positive framing	46.9% (15/32)	No Framing Effect	25.0% (9/36)	Framing Effect
Negative framing	66.7% (20/30)	$\chi^2 = 2.47$, $P < 0.116$	56.8% (21/37)	$\chi^2 = 7.60$, $P < 0.006$

Respondents are classified into two groups: Decisive respondents whose risk preference based on their emotional reactions were the same as that based on their rational analysis of the risk problem, and ambivalent respondents whose emotional preference and rational preference were different. The figures in the table represent the percentages and frequencies of the two kinds of respondents (i.e., decisive and ambivalent in relation to the total) who chose the gamble option as the overall final choice under different framing conditions.

between these two, often conflicting responses to a choice problem.[21,50–53]

To test ambivalence effects, volunteer student respondents were asked to make their choices between a sure option and a gamble of the same expected value in two hypothetical life–death scenarios: a natural disease problem and a terrorist-spread disease problem, both involving 600 individuals at risk. Instead of making a one-shot choice, the respondents were asked to first indicate what was their preferred choice according to their emotional reactions to the problem and what was their preferred choice based on their rational analysis of the problem. They were then asked to indicate their final overall choice. Each problem was presented in two framing versions. The formal structure of the two problems was identical to the Asian disease problem.

A key procedure for testing framing effects caused by incongruence between emotional preference and rational preference is to classify each respondent under each framing condition into one of the two groups: congruent risk preference group and incongruent risk preference group. Based on respondents' emotional and rational choices, they were classified into two groups under each framing condition: those who had the same emotional and rational preferences (either risk averse or risk seeking) and those who had different emotional and rational preferences. Let's call the respondents in the *congruent preference* group *decisive* respondents and those in the *incongruent preference* group *ambivalent* respondents. This classification was done for the two life–death problems separately. For each problem, the overall choice of the decisive respondents was tested for framing effects, while the overall choice of the ambivalent respondents was also tested for framing effects.

The results lend strong support to the ambivalence hypothesis of choice biases: decisive respondents show no framing effect but ambivalent respondents showed significant framing effects in both disease problems (See TABLE 4).

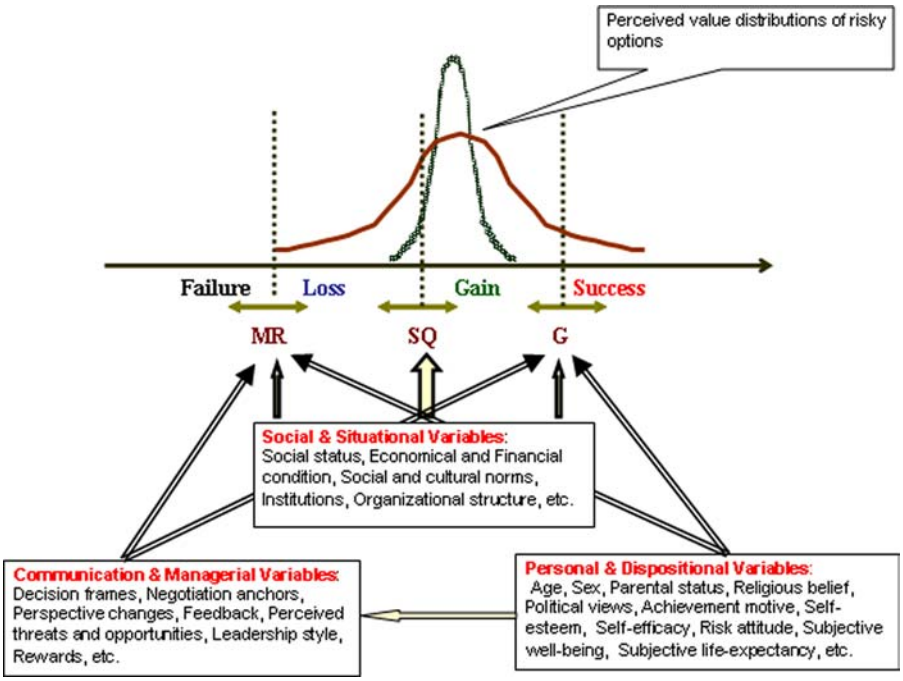

FIGURE 2. A framework for risk communication and risk preference.
MR = Minimum requirement; SQ = Status quo; G = Goal.

Conflicts in risk preference make the secondary framing cue salient and more manipulative in determining the final choice of the decision maker.

A Framework of Risk Perception, Communication, and Preference

In this final section of the chapter, I provide an overarching framework for future research on risk communication and risk preference. As illustrated in FIGURE 2, the framework presents risk as variations (distributions) in expected choice outcomes measured in terms of monetary payoff or Darwinian fitness. This distributional dimension is then demarcated by three decision reference points (goal, status quo, and minimum requirement) which characterize the state of a decision maker or a consumer of risk communication. The settings of these reference points are key determinants of risk perception and risk preference and are bounded by three kinds of variables (or vicarious cues of these variables): social and situational variables, personal and dispositional variables, and communicational and managerial variables.

This chapter focuses on joint effects of social and situational variables and communicational variables (cues) on risk perception and preference of the consumers of risk communication. The theoretical analysis and empirical evidence presented in this chapter suggest that cues embedded in risk messages are selected with priorities and are used more effectively and consistently when presented in ecologically valid situations. Judgmental errors and decision biases tend to occur as a result of ambiguous preference because of the absence of prioritized cues in risk messages or ambivalent preference elicited by conflicting cues.

A partial prescription for practical risk communication based on the theory and evidence presented in this chapter might include:

- Describe the population at risk in such a way that the communication recipients can easily infer the relationships between those at risk and themselves.
- Scale and present a risk problem in different group size situations to help decision makers gain insights into the nature of the problem.
- Be aware that different individuals have different minimum requirement, status quo, and goal and thus different preferences. One perception of the risk does not fit all.
- Experienced communication recipients are less susceptible to framing effects from secondary cues.

- Communicate clearly to avoid ambivalence resulting from ambiguity.
- Beware conflicting emotional and rational responses to risk as these lead to susceptibility to framing effects from secondary cues.

Conflicts of Interest

The author declares no conflicts of interest.

References

1. Brunswik, E. 1940. Thing constancy as measured by correlation coefficients. Psych. Rev. **47:** 69–78.
2. Simon, H.A. 1956. Rational choice and the structure of the environment. Psychol. Rev. **63:** 129–138.
3. Simon, H.A. 1990. Invariants of human behavior. Annu. Rev. Psychol. **41:** 1–19.
4. Gigerenzer, G., P.M. Todd & the ABC Research Group. 1999. Simple Heuristics that Make us Smart. Oxford University Press. New York, NY.
5. Kahneman, D. & A. Tversky. 1979. Prospect theory. Econometrica **47:** 263–292.
6. Kahneman, D. & A. Tversky. Eds. 2000. Choices, Values, and Frames. Cambridge University Press. New York, NY.
7. Kahneman, D., P. Slovic & A. Tversky. Eds. 1982. Judgment Under Uncertainty: Heuristics and Biases. Cambridge University Press. New York, NY.
8. Tversky, A. & D. Kahneman. 1981. The framing of decisions and the psychology of choice. Science **211:** 453–458.
9. Heath, C., R.P. Larrick & G. Wu. 1999. Goals as reference points. Cognitive Psychol. **38:** 79–109.
10. Locke, E.A. 2002. Building a useful theory of goal setting and task motivation. Am. Psychol. **57:** 705–717.
11. Locke, E.A. & G.P. Latham. 1990. A Theory of Goal Setting & Task Performance. Prentice Hall. Englewood Cliffs, NJ.
12. Lopes, L.L. 1987. Between hope and fear: the psychology of risk. Adv. Exp. Soc. Psychol. **20:** 255–295.
13. Stephens, D.W. & J.R. Krebs. 1986. Foraging Theory. Princeton University Press. Princeton, NJ.
14. Real, L. & T. Caraco. 1986. Risk and foraging in stochastic environments. Annu. Rev. Ecol. Syst. **17:** 371–390.
15. Wang, X.T. 1996. Domain-specific rationality in human choices: violations of utility axioms and social contexts. Cognition **60:** 31–63.
16. Wang, X.T. 2002. Risk as reproductive variance. Evol. Hum. Behav. **23:** 35–57.
17. Barrett, L., R., Dunbar & J. Lycett. 2002. Human Evolutionary Psychology. Princeton University Press. Princeton, NJ.
18. Buss, D.M. 2004. Evolutionary Psychology: The New Science of the Mind. Allyn & Bacon. Boston, MA.
19. Buss, D.M. 2005. The Handbook of Evolutionarily Psychology. J. Wiley & Sons, Inc. New York, NY.
20. Gigerenzer, G. & D.G. Goldstein. 1996. Reasoning the fast and frugal way: models of bounded rationality. Psychol. Rev. **103:** 650–669.
21. Loewenstein, G., E.U. Weber, C.K. Hsee & N. Welch. 2001. Risk as feelings. Psychol. Bull. **127:** 267–286.
22. Shanteau, J. 1992. How much information does an expert use? Is it relevant? Acta Psychol. **81:** 75–86.
23. Cosmides, L. & J. Tooby. 1996. Are humans good intuitive statisticians after all? Rethinking some conclusions from the literature on judgment and uncertainty. Cognition **58:** 1–73.
24. Tooby, J. & L. Cosmides. 1992. Cognitive adaptations for social exchange. *In* The Adapted Mind: Evolutionary Psychology and the Generation of Culture. J.H. Barkow, L. Cosmides & J. Tooby, Eds.: 19–136. Oxford University Press. New York, NY.
25. Burnstein, E. 2005. Altruism and genetic relatedness. *In* The Handbook of Evolutionarily Psychology. D.M. Buss, Ed.: 528–551. J. Wiley & Sons, Inc. New York, NY.
26. Hamilton, W.D. 1964. The genetical evolution of social behaviour. J. Theor. Biol. **7:** 1–52.
27. Trivers, R.L. 1971. The evolution of reciprocal altruism. Q. Rev. Biol. **46:** 35–57.
28. Burnstein, E., C. Crandall & S. Kitayama. 1994. Some neo-Darwinian decision rules for altruism: weighing cues for inclusive fitness as a function of the biological importance of the decision. J. Pers. Soc. Psychol. **67:** 773–789.
29. Wang, X.T. 1996. Evolutionary hypotheses of risk-sensitive choice: age differences and perspective change. Ethol. Sociobiol. **17:** 1–15.
30. Essock-Vitale, S.M. & M.T. McGuire. 1985. Women's lives viewed from an evolutionary perspective. II. Patterns of helping. Ethol. Sociobiol. **6:** 155–173.
31. von Neumann, J. & O. Morgenstern. 1944. Theory of Games and Economic Behavior. Princeton University Press. Princeton, NJ.
32. Daly, M. & M. Wilson. 1997. Crime and conflict: homicide in evolutionary psychological perspective. Crim. & Just. **22:** 51–100.
33. Real, L. 1991. Animal choice behavior and the evolution of cognitive architecture. Science **253:** 980–986.
34. Kacelnik, A. & M. Bateson. 1996. Risky theories—the effects of variance on foraging decisions. Am. Zool. **36:** 402–434.
35. Markowitz, H.M. 1959. Portfolio Selection. J. Wiley & Sons, Inc. New York, NY.
36. March, J.G. 1988. Variable risk preferences and adaptive aspirations. J. Econ. Behav. Organ. **9:** 5–24.
37. March, J.G. & Z. Shapira. 1992. Variable risk preferences and the focus of attention. Psychol. Rev. **99:** 172–183.
38. Johnson, J. & X.T. Wang. 2006. Multiple reference points as the carriers of value in risky decision making. Poster presented at the Society of Judgment and Decision Making annual meeting. Houston, TX. November.
39. Wang, X.T. 2006. A tri-reference point model of risk analysis and Communication. Paper presented at the annual meeting of the Society for Risk Analysis, Baltimore, Maryland. December.
40. Wang, X.T. & Johnson, J. 2005. Three reference points in risky decisions. Paper presented at the 5th Conference of Chinese Psychologists. Suzhou, China. July.

41. KÜHBERGER, A. 1995. The framing of decisions: a new look at old problems. Organ. Behav. Human Decision Processes **62:** 230–240.
42. KÜHBERGER, A. 1998. The influence of framing on risky decisions: a meta-analysis. Organ. Behav. Human Decision Processes **75:** 23–55.
43. LEVIN, I.P., SCHNEIDER, S. & GAETH, G.J. 1998. All frames are not created equal: A typology and critical analysis of framing effects. Organ. Behav. Human Decision Processes **76:** 149–188.
44. WANG, X.T. 1996. Framing effects: Dynamics and task domains. Organ. Behav. Human Decision Processes **68:** 145–157.
45. WANG, X.T., F. SIMONS & S. BRÉDART 2001. Social cues and verbal framing in risky choice. J. Behav. Decis. Making **14:** 1–15.
46. WANG, X.T. & K. XIN. 2002. Social-organizational knowledge and managerial decision-making. Paper presented at the third European Conference on Organizational Knowledge, Learning and Capabilities, Athens, Greece. April.
47. MACCRIMMON, K.R. & D.A. WEHRUNG. 1986. Taking Risks: The Management of Uncertainty. Free Press. New York, NY.
48. HIGHHOUSE, S. & P. YÜCE. 1996. Perspectives, perceptions, and risk-taking behavior. Organ. Behav. Human Decision Processes **65:** 159–167.
49. WANG, X.T. 2006. Emotions within reason: resolving conflicts in risk preference. Cogn. Emot. **20:** 1132–1152.
50. DAMASIO, A.R. 1994. Descartes' Error: Emotion, Reason, and the Human Brain. Putnam. New York, NY.
51. ELSTER, J. 1996. Rationality and the emotions. Econ. J. **106:** 1386–197.
52. ELSTER, J. 1998. Emotions and economic theory. J. Econ. Lit. **36:** 47–74.
53. EPSTEIN, S. 1994. Integration of the cognitive and psychodynamic unconscious. Am. Psychol. **49:** 709–724.