REPORT DOCUM

AD-A231 109

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	
2a. SECURITY CLASSIFICATION AUTHORITY DTIC ELECTE JAN 09 1991	**3. DISTRIBUTION/AVAILABILITY OF REPORT** APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	**5. MONITORING ORGANIZATION REPORT NUMBER(S)** AFOSR-TR- 90 1215

6a. NAME OF PERFORMING ORGANIZATION DEPARTMENT OF PSYCHOLOGY STANFORD UNIVERSITY	**6b. OFFICE SYMBOL** *(If applicable)*	**7a. NAME OF MONITORING ORGANIZATION** AIR FORCE OFFICE OF SCIENTIFIC RESEARCH (NL)
6c. ADDRESS (City, State and ZIP Code) BUILDING 420, JORDAN HALL STANFORD, CA 94305-2130		**7b. ADDRESS (City, State and ZIP Code)** BOLLING AIR FORCE BASE, DC 20332-6448
8a. NAME OF FUNDING/SPONSORING ORGANIZATION AFOSR	**8b. OFFICE SYMBOL** *(If applicable)* NL	**9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER** AFOSR-89-0064

8c. ADDRESS (City, State and ZIP Code)
BUILDING 410
BOLLING AFB, DC 20332-6448

10. SOURCE OF FUNDING NOS.

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT NO
61102F	2313	A4	

11. TITLE (Include Security Classification)
DECISION UNDER CONFLICT

12. PERSONAL AUTHOR(S)
TVERSKY, AMOS

13a. TYPE OF REPORT 2nd ANNUAL TECHNICAL	**13b. TIME COVERED** FROM 12/1/89 TO 11/30/90	**14. DATE OF REPORT (Yr., Mo., Day)** 11/21/1990	**15. PAGE COUNT** 10

16. SUPPLEMENTARY NOTATION

17. COSATI CODES

FIELD	GROUP	SUB. GR.
05	09	

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
loss aversion, reference dependence, decision weights.

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The present report summarizes two projects. The first project, which focuses on riskless choice, involves a series of experiments that demonstrate the phenomenon of loss aversion: losses and disadvantages have greater impact on preference than gains and advantages. The evidence shows that choice depends on the status quo or reference level, and that changes of reference point often lead to reversals of preference. To account for these observations, we develop a reference-dependent theory of individual choice, which explains such effects by a deformation of the preference map about the refererence point. Implications of loss aversion to both individual and aggregate behavior are explored.

(over)

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS ☐	**21. ABSTRACT SECURITY CLASSIFICATION** UNCLASSIFIED	
22a. NAME OF RESPONSIBLE INDIVIDUAL ALFRED R. FREGLY, PH.D.	**22b. TELEPHONE NUMBER** *(Include Area Code)* (202) 767-5021	**22c. OFFICE SYMBOL** NL

DD FORM 1473, 83 APR   EDITION OF 1 JAN 73 IS OBSOLETE.

19

19. ABSTRACT

The second project, which focuses on decision under uncertainty, extends prospect theory by incorporating a cumulative (i.e., rank-dependent) weighting scheme. In this model, the carriers of value are gains and losses, defined relative to a reference point, and the impact of uncertainty is summarized by different weighting functions for gains and for losses. Two evaluation principles -- diminishing sensitivity and loss aversion -- are invoked to explain the characteristic curvature of the value function and the weighting functions. A review of the experimental evidence and the results of a new experiment reveal a distinctive four-fold pattern of risk attitudes: risk aversion for gains and risk seeking for losses of high probability; risk seeking for gains and risk aversion for losses of low probability.

Accession For	
NTIS GRA&I	☑
DTIC TAB	☐
Unannounced	☐
Justification	

By	
Distribution/	
Availability Codes	
	Avail and/or
Dist	Special
A-1	

Decision under Conflict:

Annual Technical Report for 1990

The work during the second year of the grant has focused on two major theoretical and empirical projects involving decision under uncertainty and riskless choice. The research is summarized in two manuscripts entitled "Cumulative Prospect Theory: An Analysis of Decision Under Uncertainty" and "Loss Aversion in Riskless Choice: A Reference-Dependent Model." Both manuscripts have just been submitted for publication. The following report reviews the progress made on the two projects, further details can be found in the enclosed papers.

Loss Aversion in Riskless Choice

The classical analysis of decision making under both risk and uncertainty, which underlies much of economics, decision analysis and management science, assumes that the preference between options depends on one's tastes, but not on one's reference state. Consequently, the carriers of utility are final asset positions, not gains or losses. Although this assumption greatly simplifies the analysis of individual choice, the facts of the matter are more complex. There is substantial evidence that initial positions do matter, and that the rate of exchange between attributes (e.g., price and quality) can be quite different depending on which is acquired and which is given up. Imagine an individual who faces a choice between two positions: one job offers high status and a moderate salary, whereas the second job offers a high salary and a moderate status. We suggest that the choice between these jobs depends, among other things, on one's reference state. In particular, the first position is more likely to be chosen if one holds a high-status, low-salary job than if one holds a high-salary, low-status job because people are reluctant to accept a

loss in either status or salary. This example illustrates a basic principles of human choice, which we have labelled loss aversion: losses (i.e., outcomes below the reference state) loom larger than corresponding gains (i.e., outcomes above the reference state). For example, the amount of money required to compensate the decision maker for a change in the level of a given attribute will be higher when the change represents a loss than when it represents a gain. Because gains and losses are defined relative to the reference state, a shift of reference can change the sign of the respective outcomes and lead to a reversal of preference. Our work on loss aversion includes three parts: a) experimental investigation, b) theoretical development, and c) analysis of implications. We shall discuss these topics in turn.

a) Experimental Investigation. We have conducted a series of experimental studies designed to test for the presence of loss aversion in both riskless and risky choice. In one experiment, for example, participants were endowed with a prospect that offered equal chances to lose $5 or win $20. This prospect was matched to another prospect, with equal chances to lose $15 or win $x. Subjects had to determine the value of x for which the two prospects are equally attractive. The median value of x was $60. Thus, an increment of $40 in the possible gain was required to compensate for an increment of $10 in the possible loss. For comparison, a prospect with equal chances to win $15 or $40 was matched by a prospect with outcomes of $5 and $52. In this case, a different of $12 between the two best outcomes was sufficient to compensate for a difference of $10 between the two inferior outcomes. These data imply moderate curvature of the value function and extreme loss aversion.

In another design, a combination of a small gain and a small loss was compared to a combination of a larger gain and a larger loss. Loss aversion implies that the same difference between two options will be given greater weight if it is viewed as a difference between two c: advantages (relative to the reference state) than when it is viewed as a difference between two advantages. This prediction was tested in a study in which people chose between part-time jobs that differ with respect to daily travel time and amount of social contact. We varied the characteristic of one's present position, which presumably serves as a reference point for the evaluation of the two options. As implied by loss aversion, we found that a given difference between two options had much greater impact when evaluated as a difference between two losses (disadvantages) than when viewed as a difference between two gains (advantages).

b) Theoretical Development. In order to interpret the reversals of preference that are induced by a shift of reference point, we introduce as a primitive concept a preference relation indexed to a given reference state. Thus, $x \geq_r y$ is interpreted as: x is weakly preferred to y from reference state r. This relation serves as a basis for a reference-dependent model of choice that generalizes the standard theory (which does not include a reference state) and incorporates the notion of loss aversion. A particularly simple form, called constant loss aversion, is defined as a change of unit below the reference point. We provide necessary and sufficient conditions for constant loss aversion in the case of an additive utility function. A review of the experimental evidence suggests that choices involving monetary outcomes and consumption goods yield a loss aversion coefficient of about 2. That is, the impact of a given difference is doubled when it represents a loss instead of a gain.

c) Analysis of Implications. Loss aversion has significant implications for both individual and aggregate behavior. It underlies the large discrepancy, reported in the economic literature, between the minimal amount that people are willing to accept to give up a given object and the maximal amount that they are willing to pay to acquire it. Furthermore, because a change generally involves a gain in one attribute and a loss or another, loss aversion favors stability over change. This phenomenon, called the status quo bias or reluctance to trade, has been observed in numerous studies (see e.g., Samuelson and Zeckhauser, 1988). Loss aversion and the reluctance to trade can also shed light on the difficulty of reaching a negotiated settlement If each side views its own concession as a loss and the concession made by the opponent as a gain, then loss aversion will make mutual concessions relatively unattractive. The role of loss aversion in negotiation has been recently documented by Bazerman and Neale (1990).

Decision under Uncertainty: Cumulative Prospect Theory

Expected utility theory reigned for several decades as a dominant normative and descriptive model of decision making under uncertainty, but it has come under serious question in recent years. There is now general agreement that this theory does not provide an adequate description of individual choice; a substantial body of evidence shows that decision makers systematically violate its basic tenets. More than a decade ago, we presented a theory of risky choice, called prospect theory, which explained the major violation of expected utility theory in choice between risky prospects with a small number of outcomes (Kahneman & Tversky, 1979; Tversky & Kahneman, 1986). The present development extends prospect theory in several important respects. First, it applies to any finite prospect and it can be readily extended to

continuous distributions. Second, it is no longer limited to prospects with objective probabilities and it can be applied to unquantified uncertainty as well. Third, the present theory allows different decision weights for gains and for losses.

A theory of choice under uncertainty specifies (i) the objects of choice, (ii) a valuation rule, and (iii) the characteristics of the functions that map uncertain events and possible outcomes into their subjective counterparts. In standard applications of expected utility theory, the objects of choice are risky assets, the valuation rule is expected utility, and utility is a concave function of wealth. The empirical evidence obtained during the last two decades requires major revisions of all three tenets. We have proposed an alternative descriptive theory in which (i) the objects of choice are prospects framed in terms of gains and losses, (ii) the valuation rule is a (two-part) cumulative functional, and (iii) the value function is S-shaped and the weighting functions are inverse-S shaped. We shall briefly address these elements in turn.

(i) Framing. We distinguish two phases in the choice process: framing and valuation. In the framing phase, the decision maker constructs a representation of the acts, contingencies and outcomes that are relevant to the decision. In the valuation phase, the decision maker assesses the value of each prospect and chooses accordingly. The framing process is governed by two rules of mental economy: acceptance and segregation. The acceptance rule states that, given a reasonable formulation of a choice problem, decision makers are prone to accept the problem as presented to them, and do not spontaneously generate alternative representations. Acceptance explains why different formulations of the same problem often yield different preferences. A second rule of mental economy is the segregation of the decision problem at hand from the broader context. In accord with this rule, people frame problems by focusing on

the acts, the outcomes and the contingencies that appear most directly relevant to the choice under consideration. A prime example of segregation of outcomes is a nearly universal practice of thinking about choice problems in terms of gains and losses, rather than in terms of wealth or final asset positions.

(ii) Valuation. In expected utility theory, the utility of an uncertain prospect is the sum of the utilities of the outcomes, each weighted by its probability. The empirical evidence suggests two major modifications of the theory. First, the carriers of value are gains and losses, not final assets; second, the value of each outcome is multiplied by a decision weight, not by an additive probability. These assumptions have been incorporated into the original version of prospect theory. The new version, called cumulative prospect theory, extends the original theory to multiple uncertain outcomes and introduces different decision weights for gains and for losses. It also generalizes the standard rank-dependent model that is applied to assets rather than to gains and losses.

(iii) Subjective Scales. Two evaluation principles, diminishing sensitivity and loss aversion, are invoked to explain the characteristic curvature of the value and the weighting functions of the present theory. As in the original version, we assume that the value function is concave above the reference point, convex below it, and steeper for losses than for gains. The first two conditions reflect the principle of diminishing sensitivity: the impact of a change diminishes with the distance from the reference point. The last condition is implied by the principle of loss aversion according to which losses loom larger than corresponding gains (Kahneman & Tversky, 1984).

The principle of diminishing sensitivity applies to decision weights as well. In the evaluation of outcomes, the reference point serves as a boundary that distinguishes gains from losses. In the evaluation of uncertainty, there are two natural boundaries -- certainty and impossibility -- that correspond to the endpoints of the certainty scale. Diminishing sensitivity entails that the impact of a given change in probability diminishes with its distance from the boundary. For example, an increase of .1 in the probability of winning a given prize has more impact when it changes the probability of winning from .9 to 1 or from 0 to .1, than when it changes the probability of winning from .3 to .4 or from .6 to .7. Diminishing sensitivity, therefore, gives rise to a weighting function that is concave near 0 and convex near 1.

These qualitative properties of the value and the weighting functions have been confirmed in an extensive study of individual decision making under risk. Subjects were run individually on a computer for three separate sessions. The analysis of individual data provided strong support for a distinctive four-fold pattern of risk attitude implied by prospect theory: risk aversion for gains and risk seeking for losses of moderate and high probabilities; risk seeking for gains and risk aversion for losses of small probabilities. These data are explained by the curvature of the weighting function. Overweighting of small probabilities contributes to the popularity of both lottery and insurance. Underweighting of high probabilities contribute to both the prevalence of risk aversion in choices between probable gains and sure things, and to the prevalence of risk seeking in choices between probable and sure losses. Risk aversion for gains and risk seeking for losses are further enhanced by the curvature of the value function in the two domains. The pronounced asymmetry of the value function, which we have labeled loss aversion, explains the extreme reluctance to accept mixed prospects. The shape of the weighting

function accounts for the certainty effect and other violations of independence. It also explains why these phenomena are more readily observed at the two ends of the probability scale where the curvature of the weighting function is most pronounced. In sum, the present development provides a systematic analysis of decision making under risk and uncertainty, which is consistent with some of the major phenomena reported in the literature. It is noteworthy, however, that the present treatment does not deal with the complexities of elicitation procedures or with the effect of context, which call for different theoretical developments.

References

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47,* 263-291.

Kahneman, D., and Tversky, A. (1984). Choices, values and frames. *American Psychologist, 39,* 341-350.

Neale, M. A., & Bazerman, M. H. (1990). *Cognition and Rationality in Negotiation.* Forthcoming.

Samuelson, W., & Zeckhauser, R. (1988). Status Quo Bias in Decision Making. *Journal of Risk and Uncertainty, 1,* 7-59.

Tversky, A., & Kahneman, D. (1986). Rational choice and the framing of decisions. *The Journal of Business, 59(4), Part 2,* S251-S278.

Presentations

"Recent Developments in Judgment and Choice" -- Keynote address to the Annual Meeting of Neuroscience Society, Phoenix, AZ, November 1989.

"Cumulative Prospect Theory" -- Keynote address at the Duke Annual Conference. Duke University, Durham, NC, June 9-13, 1990.

"Constructive Decision Theory" -- Invited address at the 12th Cognitive Science Society, Cambridge, MA, July 1990.