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# INFLUENCE OF VALUES IN RISKY DECISION MAKING: A FORMALIZATION

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**Hypothetical life-situation problems used to compare individual with group risk taking share a common decision structure, which is here abstracted and formalized in decision-theory terms. By means of this formalization, risk decisions and risk shifts on life-situation problems are placed within the older, larger, and more formal literature on choice behavior. Two decision-making strategies from this literature, expected utility and minimax regret (Savage, 1951), are shown to be consistent with the relation of values (utilities) to individual risk taking found by Stoner (1968). Anomalous results for one of Stoner's 12 situations can be understood in terms of either strategy, within the context of a structural anomaly identified in that situation. The two strategies show promise for understanding the risk shift phenomenon by suggesting decision-relevant variables that may change under group discussion.**

## INTRODUCTION

It has been demonstrated that group discussion, rather than individual consideration, of life-situation problems can lead to either more or less risky decisions, depending on the problem. (See Stoner, 1968, for a review of this literature.) These results indicate that hypotheses explaining the shifts must be phrased in terms of the characteristics of each problem. Stoner's 1968 experiment has taken the biggest step in this direction by showing that initial individual decisions on a life-situation problem are consistent with the relative importance of the values involved in the problem, and that group decisions are more extreme in the same direction (risky or conservative) as the individual decisions.

The consistency between values and decisions found by Stoner suggests that subjects are using a strategy of some kind in making their decisions. Such a strategy is no more than a particular specification of *how* subjects are consistent in relating decisions to values. Understanding the strategy of initial individual decision is interesting in itself, but is perhaps even more interesting in view of the fact that discussion shifts group decisions still further in the direction consistent with values. This fact allows us to hope that understanding the strategy of initial individual decision will illuminate the shift with group discussion by drawing our attention to variables appropriate to the strategy that may change during group discussion. We take as our problem, then, the understanding of the relation of values to individual decisions by means of a decision-theoretic approach. This is a conceptual

problem, and we present no new data, although we are finally able to explain an otherwise puzzling anomaly in Stoner's (1968) data by our analysis.

## FORMALIZATION OF STONER'S PROBLEMS

The life-situation problems used by Stoner and by other experimenters in the risk shift literature were all written from intuition, rather than from any explicit format. Nevertheless, we believe that all these problems present a common decision structure, and this structure is formalized in Figure 1. Each problem presents a choice between a cautious alternative and a risky alternative. The cautious alternative leads to outcome *b* with a probability of essentially 1.0, *i.e.*, almost certainly. The risky alternative leads to success with a probability *p* that is less than 1.0. The successful outcome includes *b* and is greater than *b* by a margin of *a*, the outcome that can only be attained by success in the risky alternative. In other words, success in the risky alternative always brings the outcome that could be had with the cautious alternative, and some additional outcome *a* besides. The risky alternative leads with probability *q* ($q$=1.0 -$p$) to failure, and the outcome in the case of failure is here labeled *d*.

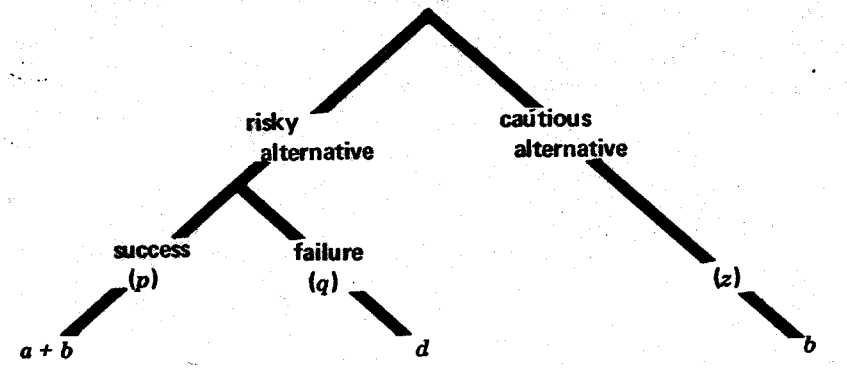


**Figure 1.** Formalization of problems used by Stoner. *a* = outcome achieved only by success in risky alternative. *b* = outcome achieved by taking cautious alternative. *d* = outcome achieved, if any, when risky alternative fails; *d* is neither *a* nor *b* in all problems but No. 6. p = probability of success in the risky alternative ( p <1.0). q = 1-p. z = probability of getting outcome *b* in the cautious alternative (z = 1.0).

The reader can assure himself that Stoner's problems indeed share the decision structure of our formalization by referring to Table 1, where we present Stoner's own summaries of his problems. (We did amplify his summary of No. 6.) We believe that the formalization also fits those life-situation problems–Kogan and Wallach, 1964–which were *not* used by Stoner, but we will not examine those problems here. After each problem summary in Table 1 are two phrases which express, in abbreviated fashion, the two values Stoner found to be associated with the alternatives of the problem. For all of the problems except No. 3 and No. 9, the two values abstracted by Stoner are the values of the two outcomes, *a* and *b*, of the formalization. For situations No. 3 and No. 9, the value statement associated with the risky alternative is "winning competitive games." This value is more like the value of *a+b* than the value of *a*, since the value of winning is more like the value of *b*, "avoiding loss in competitive games." For situations No. 3 and No. 9, the formalization still fits, but Stoner abstracted the value of *a+b* rather than the value of *a*. Thus Table 1 allows the reader to see the common decision structure of the problems and to see, for each problem, the meaning of outcomes *a* and *b* (in value terms) for that problem.

Note that, for all problems except No. 6, loss in the risky alternative leads to neither outcome *a* nor outcome *b*; in terms of the values Stoner abstracted from these problems, the value of outcome *d* is therefore no value at all, or zero value. For No. 6, outcome *d* is the same as outcome *a*, and has the value of outcome *a*, because the family will have had the trip (*a*) even if the educational savings are not replenished by continued promotion (see Table 1). We will return to this anomaly in the outcome structure of No. 6.

## FORMALIZATION OF STONER'S RESULTS

The values abstracted by Stoner from his problems were all ranked according to their importance by Stoner's subjects. Stoner found that initial decisions on a problem were relatively risky when the risk-related value was more important than the caution-related value; decisions were relatively cautious when the caution-related value was more important. This consistency between values and decisions can now be expressed in terms of the formalization. We need only interpret Stoner's value importance rankings as utility rankings to put the consistency in decision terms. In terms of our formalization, the consistency becomes: When the utility of outcome *a* [u(*a*)] was seen as greater than the utility of outcome *b* [u(*b*)], individual decisions were relatively cautious. The strength of this generalization is evident in Table 2, which sets forth, for each of Stoner's problems, the average importance (utility) rankings of the two values involved, the mean initial individual decision, and the mean group risky shift.

The measure of riskiness used by Stoner is a scale asking the subject to select the minimum odds of success (1/10 to 10/10) in the risky alternative that he would require in order to recommend the risky alternative over the cautious alternative. The initial individual decisions quoted from Stoner in our Table 2 are these minimum odds multiplied by 10. Thus mean initial decisions in Table 2 are relatively risky when less than 5.0 and are relatively cautious when greater than 5.0.

Table 2 indicates that the u(*a*) *vs.* u(*b*) comparison predicts the relative riskiness of initial individual decisions for all problems except No. 6, No. 3, and No. 9. For No. 3 and No. 9, u(*a*) *vs.* u(*b*) might have predicted initial decision and shift, but we cannot be sure because the information we have for these two problems is that u(*a* + *b*) was greater than u(*b*)–leaving open the

question as to whether u($a$) was greater than u($b$) for these two problems. Problem No. 6, on the other hand, has the appropriate u($a$) *vs.* u($b$) comparison, but the comparison simply fails to predict the initial decision and the shift.

## STRATEGIES

At this point we have formalized the decision structure common to life-situation problems in decision theory terms of probabilities and outcomes. We have expressed Stoner's consistency between values and initial decisions, in decision theory terms, as a consistency between utilities of alternative outcomes and initial decisions. Now we are in a position to examine two decision theory strategies which are consistent with Stoner's results.

First consider the expected utility strategy. Remember that the risk scale for life-situation problems asks for the minimum odds of success in the risky alternative that will make the risky alternative preferable to the cautious alternative. A subject maximizing expected utility (value) would thus calculate a minimum probability $p$ such that

$$p\,[u(a) + u(b)] + (1\text{-}p)u(d) \geq u(b) \qquad (1)$$

where it is assumed that u($a + b$) = u($a$) + u($b$). Inequality (1) follows from the formalization because the left-hand side of (1) is the expected utility of the risky alternative and the right-hand side is the utility of the cautious alternative. When u($d$)=0, it can be seen from (1) that the minimum $p$ is less than .5 (*i.e.*, is risky) only when u($a$) > u($b$).

Thus, for all problems except No. 6 (where u($d$) ≠ 0), expected utility strategy predicts risky decisions if u($a$) > u($b$) and cautious decisions ($p$>.5) if u($b$) > u($a$). This prediction cannot be tested against Stoner's results for No. 3 and No. 9, where we have ($a + b$) instead of u($a$), but all the rest of the u($d$)=0 problems show results consistent with expected utility strategy (see Table 2).

In order to introduce the second strategy, we need to reinterpret the minimum odds risk scale. Suppose that a subject is not solving an expected utility equation for minimum probability. Further, suppose that the subject does not even consider the life-situation problems in terms of probabilities; there is, after all, no information about probabilities in any of the problems. What can such a subject make of the minimum probability scale he faces? One possibility is that he interprets the scale as a preference scale, with low minimum probability (<.5) responses indicating preference for the risky alternative and high minimum probability responses (>.5) indicating preference for the cautious alternative. Consider now a second possible

### TABLE 1

Life-Situation Problems: Summary and Abstracted Values Related to Outcomes Specified by Formalization[1]

1. A dentist with a family must decide whether to undergo an operation which would remove a severe pain if successful but would prevent his continuing his dental practice if unsuccessful.
   Value of $a$: physical comfort
   Value of $b$: family financial security
2. A man about to embark on a vacation trip experiences severe abdominal pains and must choose between disrupting his vacation plans in order to see a doctor or boarding an airplane for an overseas flight.
   Value of $a$: leisure time pursuits
   Value of $b$: own life
3. A chess player must decide whether to take a manuever that might bring victory if successful or a defeat if unsuccessful.
   Value of $a + b$: winning competitive games.
   Value of $b$: avoiding loss in competitive games
4. An electrical engineer is faced with an opportunity of joining a new company with an uncertain future which, if it is successful, could offer greater chance for advancement than his present, more secure, position offers.
   Value of $a$: job challenge and advancement
   Value of $b$: maintaining a stable record of employment
5. A recent medical school graduate is choosing between two long-term projects. One is almost certain to be a success and will help his career but will not be of major importance. The other will be either a complete success or a complete failure; if successful it will lead to a cure for a "crippling disease which leaves children blind and mentally retarded."
   Value of $a$: significant contribution to society
   savings originally set aside for his sons' college education on a family trip to Europe. The education can be financed out of future earnings if the father receives probable but uncertain future promotions.
   Value of $a$: vacation with spouse and children
   Value of $b$: college opportunity for children
7. A college senior is choosing between attending a high-prestige university, which may be too rigorous for him to receive his Ph.D., and a lower-prestige university from which he is certain to obtain his degree.
   Value of $a$: best training for career
   Value of $b$: avoiding risk of career failure
8. A couple must choose between allowing a complicated pregnancy to continue, with danger to the mother's life, or having the pregnancy terminated.
   Value of $a$: becoming a mother/father
   Value of $b$: physical safety of husband/wife
9. A football captain must choose between gaining a tie on the last play of the game or attempting a play which will bring either victory or defeat.
   Value of $a + b$: winning competitive games
   Value of $b$: avoiding loss in competitive games
10. A person involved in an airplane accident must choose between rescuing only his child or attempting to rescue both his spouse and child with the realization that both will be lost if the attempt is unsuccessful.
    Value of $a$: physical safety of husband/wife
    Value of $b$: physical safety of your children
11. A recently married young man with a pregnant wife is deciding whether or not to give up his hobby of sports car racing.
    Value of $a$: leisure time pursuits
    Value of $b$: family financial security
12. A man of moderate means is considering borrowing on his life insurance to invest in a stock which may grow substantially in value.
    Value of $a$: above average standard of living
    Value of $b$: family financial security

[1] Summaries and abstracted values from Stoner, 1968.

minimum odds scale.

The minimax regret (or risk) strategy (Savage, 1951) is the strategy of the pessimist who thinks, "No matter what decision I make, the future will be exactly wrong for my decision. If I stay with my old job, the new company will turn out to be a great success. If I go to the new company it will fail. So I had better minimize the maximum regret I can feel for having made the wrong decision." This leads him to use the utilities of the various outcomes (Table 3) to calculate the possible regrets (Table 3) that can follow upon his decision. The lower left entry in the Regret section of Table 3, for example, is u($b$) − u($d$), because if he takes the risky alternative and it fails, he is left with only u($d$) although he could have had u($b$) if he had made the right decision.

TABLE 2

Rank of Values (Utilities), Initial Individual Decision, and Group Shift for Each Life Situation Problem

| Problem | Mean importance ranking of values (utilities) in problem[3] | Mean Initial Individual Decision[1] | Mean Group Shift[2] |
|---|---|---|---|
| 1. | of u($a$) = 11; of u($b$) = 6 | 7.04 | .13 |
| 2. | of u($a$) = 13; of u($b$) = 3 | 7.02 | -.75 |
| 3. | of u($a$ +$b$) = 15; of u($b$) = 17 | 3.84 | 1.48 |
| 4. | of u($a$) = 7; of u($b$) = 15 | 3.98 | .72 |
| 5. | of u($a$) = 9; of u($b$) = 16 | 3.41 | .75 |
| 6. | of u($a$) = 11; of u($b$) = 7 | 5.47 | .57 |
| 7. | of u($a$) = 9; of u($b$) = 13 | 4.91 | .71 |
| 8. | of u($a$) = 5; of u ($b$) = 2 | 8.08 | -1.01 |
| 9. | of u($a$ + $b$) = 15; of u($b$) = 17 | 4.38 | 1.35 |
| 10. | of u($a$) = 2; of u($b$) = 3 | 3.61 | 1.12 |
| 11. | of u($a$) = 13; of u($b$) = 6 | 7.34 | -.05 |
| 12. | of u($a$) = 9; of u($b$) = 6 | 7.30 | -.10 |

[1] From Stoner, 1968: Lower numbers indicate more risk.

[2] From Stoner, 1968: + shifts are toward greater risk; - shifts are toward greater caution.

[3] From Stoner, 1968: Most important value ranked *1*.

The subject chooses the decision with the minimum maximum regret. Thus, from Table 1, he prefers the cautious alternative if u($b$) − u($d$) > u($a$), but prefers the risky alternative if u($a$) > u($b$) − u($d$). With u($d$) = 0, minimax regret predicts the same behavior on the minimum odds scale, now interpreted as a preference scale, as does the expected utility strategy. This prediction, as we have already seen for the expected utility strategy, corresponds to Stoner's results for all his u($d$) = 0 problems except No. 3 and values abstracted correspond to u($a$) and u($b$) of the formalization, but the u($a$) *vs.* u($b$) comparison predicted cautious decision when in fact problem No. 6 showed marginally risky decisions and a risky shift with group

TABLE 3

Minimax Regret Analysis

| Outcome of Risky Alternative | Alternative Decisions: Risky | Alternative Decisions: Cautious |
|---|---|---|
| | Utilities | |
| Success | u($a$) + u($b$) | u($b$) |
| Failure | u($d$) | u($b$) |
| | Regrets | |
| Success | 0 | u($a$) |
| Failure | u($b$) − u($d$) | 0 |

discussion. This anomaly is made comprehensible by noting that No. 6 is the only problem for which $d$ is not loss of both $a$ and $b$; rather, $d$ is the same as $a$ (see Tables 1 and 2). By letting u($d$) equal u($a$) in both the expected utility and minimax regret calculations, the reader can satisfy himself that this structural anomaly in No. 6 acts to increase the attractiveness of the risky alternative. Thus either expected utility or minimax regret, in conjunction with the formalization, explains the marginally risky initial decisions found for No. 6.

## CONCLUSION

We began with a formalization of the common decision structure shared by the life-situation problems. This formalization is interesting in the first instance because it identifies the class of decision problem to which the laboratory group shift results may be generalized. In addition, the formalization allowed us to express Stoner's consistency between values and initial decisions in decision terms. Thus expressed, Stoner's results are shown to be consistent with either two decision theory strategies: expected utility or minimax regret.

We have not attempted to answer two questions that arise from this decision theory approach to the risk shift on life situation problems: 1) Which strategy are subjects using in making initial individual decisions? 2) What causes the shift with group discussion? Answering the first question amounts to determining whether perceived probability of success affects choice between risky and cautious alternatives, since the differences between the two strategies is that expected utility takes account of probabilities and minimax regret does not. This question cannot be answered with a minimum odds scale because, even if the subject does consider probabilities, the minimum odds scale asks him to eliminate considerations of actual probability in stating the minimum probability he would require to

perceived probability of success scale be used in future research with life-situation problems in order to answer this question of strategies. Madaras and Bem (1968) used both scales, but their data is not presented in a way that will tell us the extent to which perceived probabilities of success affect decisions on the life-situation problems.

The second question, the question of causes of the group risk shifts, can profit by a decision theory perspective. Stoner's data indicate that individuals make risk decisions according to a strategy that takes into account evaluation of outcomes. The result of our analysis suggests that understanding group effects on risk decisions requires understanding group effects on individual evaluation of outcomes or on individual strategy. For instance, we note that the group shifts tend to occur in the same direction, either risky or cautious, as the initial individual decisions for any given problem (Table 2). This result suggests that the group shifts may result from enhancement of either expected utility or minimax regret strategy; that is, subjects may be brought to stronger or more frequent application of one or the other strategy after group discussion. Marquis and Reitz (1969) have in fact found support for this hypothesis as applied to explicit betting decisions. Another possible hypothesis for the group shift is that group discussion may enhance the perceived difference between u($a$) and u($b$), which, by either expected utility or minimax regret, would make risky initial decisions more risky and cautious initial decisions more cautious. Vroom and Deci (1971) have argued explicitly that changes in utility of values associated with risky and cautious alternatives may cause group risk shifts, and Vinokur (in press) has shown that shifts in utility of outcomes do at least accompany group risk shifts.

The cause of group risk shifts, then, may be reevaluation of outcomes in decision problems, or reification of decision strategy, or both. These two hypotheses to which we are led by consideration of individual decisions are not, as we noted above, original with us. But our decision analysis leads us to see these group shift hypotheses together in a context that did not exist before, to see them as more likely (in light of decision theory consistency with individual decision making), and to see them as distinct from those versions of value theory (Brown, 1965) which posit generalized social values of risk and caution. This last point is conceptually very important. Both these hypotheses are value hypotheses, but both deal with values implicated in the decision problem, rather than with *supra*-problem values of risk or caution.

Obviously a decision theory approach, while it resolves the anomaly of problem No. 6 in Stoner's results, opens new questions about both initial individual decisions and group risk shifts. We maintain that these questions are heuristic dividends of making clear that the life situation problems are related to an older and more formal literature of decision theory.

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