THE EFFECT OF ANXIETY AND DEFENSIVENESS ON TESTING EXPECTATION THEORIES OF DECISION MAKING

by

William Taylor Wilson

B.Sc., University of British Columbia, 1963

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

in the Department

of

Psychology

We accept this thesis as conforming to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

November 1965

In presenting this thesis in partial fulfilment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the Head of my Department or by his representatives. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Department of Psychology

The University of British Columbia
Vancouver 8, Canada

Date December 24, 1965

ABSTRACT

The general purpose of this study was to examine one approach to the study of the relationship of personality variables to expectation theories of gambling. The Coombs and Bezembinder (1964) method of testing expectation theories of gambling behavior was used to determine how many, among a group of 77 subjects, obeyed each of four expectation theories. These four expectation theories were: EV theory, assuming the maximization of the product of objective prize values and actual probabilities of winning; EU theory, assuming maximization of the product of subjective prize values and actual probabilities of winning; SEV theory, assuming the maximization of the product of objective prize values and subjective probabilities of winning; and SEU theory, assuming the maximization of the product of subjective value of the prize and the subjective probability of winning.

The Coombs and Bezembinder method consists of comparing an estimate of an individual's consistency of choices independent of expectation theory assumptions with estimates of consistency under assumptions basic to each of the four expectation theories. A lower value of the consistency estimate under assumptions of a given expectation theory than the value calculated independently of any expectation theory assumptions leads to rejection of that

particular theory as a model for the subject's behavior. The Coombs and Bezembinder technique for determining whether an individual obeys the four expectation theories leads to the prediction of an ordering of the expectation theories with respect to the number of subjects who do not satisfy them.

The procedure in the present study involved the presentation of 96 pairs of one-outcome gambles to 77 subjects in an introductory psychology class. A subject was required on each pair to choose between a gamble combining high risk with a large prize and a gamble combining a low risk with a small prize. It was found that EV theory was rejected for 57 subjects, EU theory for 31 subjects, SEV theory for 26 subjects and SEU theory for 14 subjects. The hypothesis of monotonicity in the number of rejections for the two sequences SEU-SEV-EV and SEU-EU-EV was accepted. A second hypothesis, that a higher proportion of females will obey the expectation theories than will males, was rejected.

The subjects were subdivided into high and low anxious and high and low defensive groups groups on the basis of scores obtained on the Alpert and Haber Test Anxiety Scale and the Crowne and Marlowe Defensiveness Scale. An examination of the data was sufficient to reject the hypothesis that more low anxious-low defensive and high anxious-high defensive subjects would obey the four expectation theories than would subjects who were either low anxious-high defensive or high anxious-low defensive.

There were, however, some statistically significant results obtained on the basis of several ad hoc analyses. Fewer high defensive males than low defensive males appeared to obey SEV theory. Furthermore, fewer males who were either high anxious-high defensive or low anxious-low defensive obeyed SEU and SEV theory than did males who were either low anxious-high defensive or high anxious-low defensive. On the basis of these results, it was recommended that further research be conducted on the relationships of personality variables to expectation theories of gambling.

It was noted that the use of the Tversky method of testing expectation theories would permit the simultaneous examination of two approaches to the relationship of personality variables to decision making (personality variables versus propensity for risk and personality variables versus rationality of decision).

Finally, with respect to technique, it was recommended that better ways of assessing personality variables be found and the subjects be fully trained and run individually through the experiment.

TABLE OF CONTENTS

PAGE

Abstract. ii

INTRODUCTION. 1

PROCEDURE. 20

Method. 20

Analysis of Data. 23

RESULTS. 37

DISCUSSION. 55

SUMMARY AND CONCLUSIONS 62

BIBLIOGRAPHY. 65

APPENDIX I. Discussion of Five Theorems on Expectation Theory 69

APPENDIX II. Sample Booklet. 76

LIST OF TABLES (continued)

TABLE		PAGE
13.	Classification of Subjects Satisfying Each of the Four Expectation Theories by Personality Types . .	50
14.	The Number of High and Low Anxious and High and Low Defensive Subjects Falling Into the Upper and Lower Quartiles on the Coombs and Bezembinder PI Consistency Estimate	53
15.	The Number of Male and Female Subjects Satisfying Each of the Four Expectation Theories.	54

INTRODUCTION

Every action that an individual makes in a multi-stimulus world implies the previous elimination of one or more alternatives. What determines the course of action that an individual will pursue? In attempting to answer this question one must assume that the individual is motivated to choose the course of action that will result in his receiving the greatest amount of benefit. The specialized aspect of this problem dealt with by decision theory is the problem of predicting an organism's behavior when it is faced with a series of alternative actions having finite probabilities of leading to the desired consequence.

Suppose the individual in striving toward a desired goal is faced with several alternative courses of action leading to unknown consequences. Suppose further that not all of the possible courses of action lead to the desired goal. That is, there is an element of risk involved. What factors govern the behavior of the individual? A simple paradigm for these conditions is a gambling situation. The individual is required to predict one or more outcomes from a list of possible outcomes resulting from a given action such as rolling dice. The action is then performed and the

outcome noted. The individual receives or forfeits some benefit (usually a sum of money) depending upon whether the actual outcome is a member of the set of predicted outcomes that the individual chooses. The hedonistic answer, that an individual will make his choice in such a manner as to maximize the resulting benefit to himself, introduces a number of problems. For instance, how can an outside observer determine the benefit received by the individual?

As early as the eighteenth century Bernouilli (1954) introduced the concept of "utility" to denote the lack of agreement between the paper value of money received as a prize in a gambling situation and its value as perceived by the recipient (subjective value). Furthermore, the list of benefits received by the individual may not be exhausted by the enumeration of goods and monies that change hands as a result of a given gamble.

In the following paragraphs four models or theories which attempt to deal with the difficulties arising out of an attempt to predict an individual's behavior in a gambling situation will be discussed and evaluated.

Edwards (1954) described four models which have been used as a basis for the experimental study of gambling decisions. These are defined by the equations used to calculate

their values, and are:

$$E\,V = p_i V_i \quad (1)$$

$$E\,U = p_i U_i \quad (2)$$

$$S\,E\,V = S_i V_i \quad (3)$$

$$S\,E\,U = S_i U_i \quad (4)$$

where p_i is the actual probability that a given event i will occur, where s_i is the subjective probability that the player feels that the event will occur and where V_i is the actual monetary gain accruing to the individual as a result of the occurrence of the event i. U_i is the subjective value or utility of the money accruing to the individual as a result of the occurrence of event i. All four models of decision-making derive from the mathematical result that if an alternative associated with a prize of value v occurs with a probability p, then, in the long run, an individual would expect to end up with $p \times v$ dollars if he invariably selects this alternative. Thus, if the probability of winning a $10.00 bet is .5 then at the end of 100 bets, for example, one would expect to have won $500.00 (100 x .5 x $10 = $500). The other models incorporate other factors which may determine the choice of a given individual. EU theory allows for the introduction of Bernouilli's concept of subjective utility for money. SEV theory permits the introduction of subjective

probability preference, a concept popularized by Edwards (1953) as a result of his discovery that some individuals prefer, or tend to prefer, events that have .5 probability to those which have .75 probability of winning when the EV of both bets was maintained at a constant value. SEU theory allows the incorporation of both Bernouilli's concept of utility and Edwards' concept of subjective probability. The basic assumption underlying any of the expectation models of decision making is that the individual will choose an alternative that will maximize the value of the particular expectation representing the given model. Tests of the theory become empirical measures of how many individuals behave in a manner consistent with a given theory. An example may help to clarify the application of these theories. Consider the following four outcome gamble where P_i is the probability of the value V_i:

Event	P_i	V_i	EV (Mathematical Expectation)
1	.2	$9.00	$1.80
2	.3	$8.00	$2.40
3	.5	$4.00	$2.00
4	.5	$4.40	$2.20

Assume that the prize for the occurrence for event 2 is a $2.40 non-transferable pass to a concert which, however,

occurs on a day on which it is impossible for the individual to attend. The prize for event number 3 is a $4.00 ticket for a play that the individual was, in fact, going to attend, but for which the tickets were sold out with the result that the individual was going to have to pay $5.00 from a ticket scalper. Assume further that the cash prize of $9.00 is preferred a great deal more by the individual to the cash prize of $4.00. Finally, assume that the individual had a premonition that the outcome of event number 4 is slightly more likely than the outcome of event number 2, and that event number 1 is only slightly less likely than event number 3. If EV theory was applied as a model for the individual's behavior we would predict that the individual would choose alternative number 2, since this alternative provides the greatest mathematical speculation of return. If EU theory is used as a model of behavior, one would predict that the individual would choose alternative number 3 because the subjective utility of the ticket which is the prize is $5.00, raising the expected value of that alternative to .5 x $5.00 or $2.50. If SEV theory is used as a model, one assumes linear utility for money, but allows for idiosyncracies in probability preference, with the result that one would predict that the individual would choose event number 4. Finally, if SEU theory is used as a model which permits consideration of both

the subjective effects of probability and prize preference, one would predict that the individual would chose alternative number 2 because the probability preference is only slightly less than for alternative number 4, but the prize is very much more preferred.

Pruitt (1962) has made an excellent evaluation of these models and the following discussion relies heavily on that source. The evaluation of the three models was made by Pruitt on the basis of three criteria: first, the range of alternatives within which each model has predictive value, secondly, the accuracy with which each model predicts decision within its range; and thirdly, the examination of whether a model containing a subjective parameter is any better than the comparable model containing an objective parameter within the ranges in which both models have predictive power.

The objective models EV, SEV, and EU are applicable only to situations where the objective parameters (i.e., probability and value) are defined and known by the gambler.

The EV model seems inadequate in the range of gambles in which there are small probabilities of winning large amounts of money, such as in the purchase of lottery tickets (Allais, 1953; Bernouilli, 1954). EV seems to be a poor

predictor of choice behavior when the difference between two gambles in EV as defined by equation (1) is small, provided that the range of gambles involves only moderate probabilities and values of outcomes. The predictive power of EV theory increases, however, as the difference in expected value increases. Thus, in the case in which the EV value of two bets is identical, EV theory predicts that there will be no preference, whereas Coombs and Kormorita (1958), Edwards (1953) have found consistent preferences. Mosteller and Nogee (1951) found an increase in correct predictions from 42 percent to 67 percent when the difference in EV between two bets was increased from less than 50 cents to $2.50. Edwards (1954a) suggests that the less complex the bets between which a decision is made, the more accurate the EV model will be as a predictor of decisions.

Regarding the SEV model, Pruitt (1962) states that if a person will bet at all on a chance event, he will put all his money on that event, a prediction which is obviously not upheld at the race track and in many other situations. This interpretation of SEV, however, seems to rest on a false interpretation of subjective probability. Just because an individual subjectively prefers one probability does not mean

that he automatically assigns a zero probability to every other possible event. Thus, recognizing the possibility of other outcomes, there is no reason for him to risk all his capital on a single alternative.

The SEV model is moderately accurate in predicting choices between simple bets which differ in probability of winning or losing but whose outcome involves the same level of money (Edwards, 1953, 1954a, 1954b, 1954c; Coombs and Pruitt, 1960). Suppes and Walsh (1959) found that SEV predictions on two outcome bets with a subjective probability of winning of .5 were correct only 57 percent of the time. This finding indicates a second generalization. The SEV model is only slightly, if any, better than the EV model in the case in which the probabilities of winning and losing remain constant but the monetary outcome level varies.

The major difficulty associated with EU and SEU models is that utility is difficult to measure. Edwards (1961) developed a method of measuring utility and testing EU theory but later discarded it as invalid. An attempt at measuring utility by Coombs and Kormorita (1958) on three subjects had 29 out of 30 correct predictions but all 30 would have been correct under the assumption that the subjects preferred a

higher probability of winning to a lower probability of winning. Mosteller and Nogee (1951) generated utilities for money and then used these utilities to test EU theory. They found 66 percent correct predictions as opposed to 50 percent correct predictions with the EV model for a number of different levels of probability and money. The predictions increased in accuracy up to 93 percent in pairs in which the difference was over $2.50. Unfortunately, accuracy in EV predictions will also increase as the money value increases. This fact partially vitiates the above findings. There seems, however, to be some ambiguity in interpretation of the measurement of utility since the subjective difference in utility could be as well explained by a probability preference. Consider the gamble A which is won with a probability .5 and prize valued at $6 and is preferred to gamble B which is won with a probability .48 and prize valued at $6.50. One might explain the choice as a preference for the probability .5 or as a preference for the prize of value $6. The conclusion stated by Pruitt (1962) is that EU theory is somewhat better than EV theory when differences between EU in paired choices are small and improves markedly as differences increase, subject to ambiguities in the measurement of utility.

Most tests of the SEU model have used a chance event ($p = .5$) with a result that SEU theory remains essentially untested over a large range of probabilities. Suppes and Walsh (1959) used a die with three sides covered with the nonsense symbol ZOJ and three sides covered with the nonsense symbol ZEJ so as to eliminate preconceived probability preferences. The subject was forced to choose between two gambles with prize values ranging from +40 cents to -40 cents. The outcome of the gamble was determined by the roll of the die. They found that the SEU model predicted 58 percent correct choices as compared to 57 percent for the SEV model. Davidson, Suppes and Siegel (1957) attempted to measure utility of phonograph records by a linear programming method. Using the utilities obtained, they tried to measure the subjective probabilities attached to various gambles and thus to test for SEU maximization. The results showed that SEU theory was able to predict correctly a minimum of 67 percent and a maximum of 71 percent of the choices.

Pruitt (1962) has suggested two directions for research on gambling behavior: traditional models may be refined or new models may be postulated and tested. With

regard to the second alternative, he introduces a pattern and level of risk model (PLR) which is applicable only to bets having at least one negative outcome. This model has had some success in predicting choices in situations where the other four models fail but has the weakness that modifications are required to explain choices in situations in which no negative alternatives occur.

A second alternative is one based on measuring the variance preference. Thus two bets could have the same expectation value and the same probability of winning or losing but one bet could involve a large prize for winning and a large negative prize for losing while the other gamble involves small losses and gains. The former gamble has a large variance while the latter gamble has a small variance. Studies in this area have been made by Royden, Suppes and Walsh (1959); Davidson, Suppes and Siegel (1957); Coombs and Kormorita (1958); and Coombs and Pruitt (1960). These models have made some correct predictions in cases in which the utility models have failed but a major shortcoming is that the methods of measuring variance preferences can be interpreted in terms of a utility function for money. This means, if an individual has a variance preference then he prefers only bets of a certain dollar value. This is the equivalent to having a utility

function for money since a utility function implies a prediléction toward bets of a given dollar value.

The preceding discussion suggests that one of the basic problems in testing the SEU or SEV models is in the difficulty of forming a "good" and independent estimate of both utility and subjective probability. Coombs and Bezembinder (1964) have developed a method of testing these theories without requiring an estimate of subjective probability and utility. They have reported that for 36 subjects EV theory was rejected for 34 subjects, EU theory was rejected for 7 subjects, SEV theory was rejected for 7 subjects, and SEU theory was rejected for 2 subjects. Thus, in this context, SEU had the widest general applicability for prediction of choice behavior.

Coombs and Bezembinder's method depends on five theorems which are described in detail in Appendix I. These theorems deal with the prediction of gambling choice between pairs of bets when the prize values and probabilities are varied sequentially. Pairs of bets can be presented to the subject in such a manner that the mathematical expectation (EV) of the gambles with the higher probability of winning is

originally greater than the mathematical expectation value of gambles with the lower probability of winning. As the probability of winning is systematically decreased for both members of the pair, these five theorems predict a point after which the subject should choose the bet with the lower probability of winning in order to maximize value and utility of the prize.

The first part of this introduction has discussed research attempting to develop more adequate methodological techniques for determining the validity of the four expectation theories of gambling behavior. Gambling behavior, however, is a subset of the class of behaviors known as risk taking. Several research studies have dealt with finding personality correlates of risk taking behavior. An examination of this research on personality correlates of risk taking might, therefore, help to isolate the personality types best obeying the four expectation theories. Slovic (1964) has reviewed much of the experimental work done in an attempt to find personality correlates of behavior.

Atkinson (1957) found that subjects with high motives to achieve preferred bets with intermediate probability of success whereas subjects with high motives to avoid failure

chose bets with high or low probabilities of success. A further study by Atkinson (1960) corroborated this finding. Scodel, Ratoosh and Minas (1959) found individuals with high need achievement, theoretical aesthetic values and fear of failure chose more conservative bets.

Brody (1963) found that subjects rated high in need achievement and low in test anxiety as measured by the Mandler Sarason Test Anxiety questionnaire (Mandler and Sarason, 1952) tended to increase confidence rapidly in the correctness of their choice up to the 50 percent level and then to increase more slowly as compared to low need-achievement high test anxiety persons. Further, a high need for achievement was found to be associated with a higher estimate of the subjective probability of success for a given bet. Rim (1964) found that individuals high on an extroversion scale took greater risks in a gambling situation than those scoring low on the scale. In a group situation those individuals scoring moderate in an extroversion and a neurotocism scale shifted much more toward riskier behavior from their individual behavior than did either those scoring low or high on the scales. Stone (1964) found scholastic performance was

negatively related to utility for risk whereas an agreeing response set was positively related. Intelligence and anxiety as measured by the Taylor Manifest Anxiety Scale in this study was found to be unrelated to utility for risk.

Kogan and Wallach (1964) have measured the effect of test anxiety as defined by the Alpert and Haber (1960) scale and defensiveness as defined by the Crowne and Marlowe (1960) scale on risk taking behavior. The results from this study indicate that individuals classed as high anxious and high defensive and low anxious-low defensive tended to exhibit a more stable or consistent pattern of risk taking behavior than low anxious-high defensive or high anxious-low defensive individuals.

The similarity in behavior of opposite groups was explained as the result of two mechanisms. In the case of the high anxious-high defensive individuals, consistency of behavior was said to have resulted from the development of a common pattern of action derived to meet an emotionally arousing situation. In the low anxious-low defensive groups, the consistency of behavior over several situations was said to be due to a rational or cognitively perceived similarity among these situations. There were three types of situations

examined in the experiment. First, skill games, that is, games in which the individual was required to bet on the attaining of a goal that depended only on his own skill. Second, actual gambles or situations in which the individual won or lost a sum of money dependent on the chance occurrence of an event. Thirdly, hypothetical gambles which consisted of asking an individual how much he would be willing to risk on the occurrence or non-occurrence of a certain chance event. It was found that females tended to behave more similarly across these three types of situations than did males.

The above studies deal with three personality correlates of risk taking behavior: need for achievement, defensiveness and anxiety. The need for achievement has been further reduced into a need to avoid failure and a need to succeed. Defensiveness would seem, a priori, to be closely related to the first of these components, the need to avoid failure. The apparent contradictory findings on the effect of anxiety on risk taking behavior reported by Stone (1964), Kogan and Wallach (1964) and Brody (1963) diminish upon examination of the types of anxiety being measured in each case. The latter two studies use a form of test anxiety and report a positive relationship with risk taking behavior while Stone, using the

Taylor Manifest Anxiety Scale reports no relationship to risk taking behavior. One possible conclusion to be drawn from these findings is that test anxiety and whatever is common to defensiveness and need achievement are related to risk taking behavior. It would seem appropriate to use these personality findings to attempt to form a more adequate test of the expectation models of gambling behavior. A possible outcome of this type of investigation would be that some personality types obey one expectation theory while other personality types obey another.

It would seem desirable to apply the personality findings to the Coombs and Bezembinder method of testing expectation theories for several reasons. It avoids the problem of measuring utility and subjective probability independently and it presents a series of gambles covering a range of probabilities rather than just a single probability. The sequence of presented gambles allows the presentation of a range of expected values of the various theories. The Coombs and Bezembinder method of testing the four expectation theories of gambling involved the presentation of a set of gambles three times and the evaluation of the consistency of behavior on identical gambles. If the individual behaved in

a random manner, he was discarded from the analysis. It could thus be determined, for all Ss satisfying the Coombs and Bezembinder randomness criterion, whether personality variables affecting behavioral consistency had any effect on whether an individual obeyed the restrictions of the four expectation theories.

Kogan and Wallach (1964) found that low anxious-low defensive and high anxious-high defensive individuals were more consistent in their behavior than the other two groups of individuals. It would thus be expected that these two groups would tend to obey the restrictions imposed by some of or all of the expectation models of gambling behavior to a greater extent than the other two groups. Furthermore, since Kogan and Wallach have already found that females were more consistent than males in their risk taking behavior, it might also be reasonable to expect that females would tend to obey the four expectation theories to a greater extent than males. The principal purpose of the present study was to test these predictions in an experiment consisting of the presentation of the Coombs and Bezembinder gambles conjoined with the anxiety and defensiveness questionnaires to male and female subjects. Questionnaire scores split at the median for the entire group provide a basis for dividing the subjects into four personality groups: low anxious-low defensive, high anxious-

high defensive, low anxious-high defensive, high anxious-low defensive. These groups can then be separately evaluated for conformance to the four expectation theories as can the male and female subgroups.

Another prediction is suggested by the Coombs and Bezembinder technique for testing the four expectation theories. This technique requires that an individual satisfy an increasingly stringent set of assumptions as the number of "subjective" parameters representing his behavior is reduced from two in the case of SEU theory to zero in the case of EV theory. There are thus two possible sequences of expectation theories in which the number of rejections should be monotonically increasing: SEU-SEV-EV and SEU-EU-EV.

These predictions may be formalized with the following experimental hypotheses:

1) More low- anxious-low defensive and high anxious-high defensive individuals will obey the given expectation theories than will members of the other personality groups.

2) A higher proportion of females will obey the expectation theories than will males.

3) Monotonicity will be observed in the number of rejections of each theory for the two sequences: SEU-SEV-EV and SEU-EU-EV.

The experimental design also permits a preliminary, purely exploratory analysis of possible differences among individual personality types obeying the four expectation theories.

PROCEDURE

Method

Fifty six male and twenty one female first year University of British Columbia psychology students were tested as a group during the last half hour of a regular class period. All Ss were provided with identical test booklets containing instructions, 96 pairs of gambles and two personality questionnaires.

Instructions for the task read as follows:

> Please Do Not Open the Booklet Until Told To Do So
>
> At the top of the booklet indicate whether you are male or female. Do not place your name on the booklet. Pictured below is a pair of gambles. Each pattern has a spinner that rotates. If the spinner stops on the shaded area of a particular pattern, the prize is the amount of money stated above the pattern. If the spinner stops on the unshaded portion of the pattern, nothing is won or lost.
>
> Place a check inside the gamble which you would chose if you were only allowed to play one of the gambles. On the following pages are a series of pairs of gambles.

> Place a checkmark in the member of each pair that you would prefer to play. Make a choice on each pair. Following the series of patterns, there are two questionnaires. Please fill these out according to the instructions at the top of the questionnaire.
>
> At the end of the experiment, ten people will be chosen at random from the class to play one of the gambles on the questionnaire for the cash prize indicated on the booklet. Each of these persons must, however, play the gamble in the way in which he indicated his choice on his booklet.

The contents of this booklet have been reproduced in Appendix I. The 96 pairs of gambles were each presented on separate pages of the booklet in order to reduce the effects of previous choices upon the gamble at hand. The gambles were presented in a form similar to the pair that appears in the above instructions differing only in the fact that a sum of money representing the prize was indicated above each gamble. The amount of money and the probability of winning the gamble were varied systematically although the choice for the subject was always between a high risk-high prize gamble and a low risk-low prize gamble.

The final sections of the booklet consisted of the Alpert and Haber Test Anxiety Scale and the Crowne and Marlowe Defensiveness Scale. The Alpert and Haber Test Anxiety Scale is based upon the principle that specific anxiety and general

anxiety are different concepts operationally measured on two separate scales. The test consists of two scales, a facilitation scale of nine items of the prototype "Anxiety helps me to do better during examinations" and a debilitation scale stating the inverse sort of relationship. The items are randomly mixed from both scales into a single questionnaire. Each item is answered on a five point scale designated by the adverbs: always, often, sometimes, seldom, and never. Alpert and Haber (1960) report a test - retest reliability coefficient over a ten week period of .83 for the facilitating scale and .87 for the debilitating scale. The Crowne and Marlowe Defensiveness Scale was developed in an attempt to measure social desirability independently of psychopathology. A set of items was drawn from the population of "behaviors" which are culturally sanctioned and approved but improbable, (e.g. "I <u>never</u> hesitate to go out of my way to help someone in trouble."). Crowne and Marlowe (1960) report an internal consistency for this test (Kuder-Richardson) of .88 and a test - retest reliability coefficient over a one month interval of .89.

The instructions were read aloud by the experimenter who also solicited questions about the task before allowing the Ss to proceed. The Ss then indicated which gamble in

each of 96 pairs they preferred. Space was provided at the top of the booklet for the subject to indicate his sex.

In order to promote a more realistic approach to the gambling task, the subjects were told that at the conclusion of the experiment, ten individuals would be chosen at random to play one of the gambles for real money. The only restriction imposed was that each of the selected Ss must choose the member of the selected pair of gambles that he had previously indicated in his test booklet. Since there was no possibility of losing money and a good chance of winning, it was reasoned that this would provide sufficient motivation for completing the booklets as though real gambles were involved. The fact that a number of students expressed interest in the experiment and participated in a discussion after the testing was completed provided qualitative evidence for the correctness of this reasoning.

Analysis of Data

The analysis consisted of two major steps; first, the examination of each of the subject's gambling patterns to determine if the assumptions of any of the four expectation theories were met. Second, in order to provide a better test

of the expectation theories, the subjects were further divided into personality groups by splitting scores on the questionnaires at the median.

The method for determining whether an individual obeys the assumption of a given expectation theory was done on a computer to avoid many tedious hand computations.

The 96 pairs of gambles in the test booklet were composed of three identical sets of 32 pairs of gambles. The probability of winning and value of prize for each of these 32 pairs is given by Coombs and Bezembinder (1964) and are reproduced in Tables 1 to 4. Employing the Coombs and Bezembinder technique, it was determined whether each subject obeyed any or all of the expectation theories. This technique is a two step process. First, for each of the 32 different gambling patterns, it was noted how many times the subject chose the left alternative on each of the three presentations. From this, an estimate of the individual's consistency in behavior independent of any theoretical restrictions was obtained. The second step involves the estimate of the subject's consistency in his choice behavior under the additional restriction imposed by the four expectation theories. If this new consistency estimate is no smaller than the original

Table 1
Expected Values of the gambles comprising Set I

Set I: $v_l = .80$, $v_r = 1.20$

P_l	EV_l	P_r	EV_r
.9	.72	.8	.96
.8	.64	.7	.84
.7	.56	.6	.72
.6	.48	.5	.60
.5	.40	.4	.48
.4	.32	.3	.36
.3	.24	.2	.24
.2	.16	.1	.12

Table 2
Expected values of the gambles comprising set II

Set II: $v_l = 1.70$, $v_r = 2.30$

P_l	EV_l	P_r	EV_r
.9	1.53	.8	1.84
.8	1.36	.7	1.61
.7	1.19	.6	1.38
.6	1.02	.5	1.15
.5	.85	.4	.92
.4	.68	.3	.69
.3	.51	.2	.46
.2	.34	.1	.23

Table 3
Expected values of the gambles comprising Set III

Set III: $v_l = 2.80$, $v_r = 3.20$

P_l	EV_l	P_r	EV_r
.9	2.52	.8	2.56
.8	2.24	.7	2.24
.7	1.96	.6	1.92
.6	1.68	.5	1.60
.5	1.40	.4	1.28
.4	1.12	.3	.96
.3	.84	.2	.64
.2	.56	.1	.32

Table 4
Expected values of the gambles comprising Set IV

Set IV: $v_l = 3.70$, $v_r = 4.30$

P_l	EV_l	P_r	EV_r
.9	3.33	.8	3.44
.8	2.96	.7	3.01
.7	2.59	.6	2.58
.6	2.22	.5	2.15
.5	1.85	.4	1.72
.4	1.48	.3	1.29
.3	1.11	.2	.86
.2	.74	.1	.43

estimate of consistency, it is assumed that one can not reject that particular expectation theory as a model for the subject's gambling behavior. The method used to estimate the required consistencies will be explained in more detail in the following paragraphs.

In order to estimate a subject's consistency without regard to theory (P_i), it was determined for each of the 32 different pairs of gambles in Tables 1 to 4 whether the subject had chosen the left gamble 0,1,2, or 3 times out of the three times the pair was presented to him. If the individual chose the left gamble three or two times, a one is placed opposite the representation of the particular gamble in Tables 1 to 4. If he chooses the left gamble, zero or one time, a zero is placed in the corresponding entry. An example of this method of recording the data appears in Table 5. Because the scores of 3,2,1 and 0 are reduced to scores of 1 and 0, this method of recording the data will be called the reduced matrix form. This reduction of the data makes it much easier for the subsequent calculations to be made.

The consistency of an individual is related to the probability that he will make his dominant choice on a given gamble. Thus, if he is completely consistent he will make

Table 5

Sample Scoring of Data in Reduced Matrix Form (p_L is the probability of winning if the left gamble is chosen)

p_L	p_r	Set I	Set II	Set III	Set IV
.9	.8	0	0	0	0
.8	.7	0	0	0	0
.7	.6	0	1	0	1
.6	.5	0	1	0	1
.5	.4	0	1	0	1
.4	.3	0	1	0	1
.3	.2	1	1	1	1
.2	.1	1	1	1	1

his dominant choice all the time (i.e., always choose the left gamble or always choose the right gamble). If PI_i is the probability that the individual makes his dominant choice on any pair of gambles and L_i is the proportion of times that the individual is observed to have made either three left choices or three right choices, then it follows that L_i is equivalent to the probability of making three left choices plus the

probability of making three right choices.

$$L_i = (PI_i)^3 + (1 - PI_i)^3 \qquad (1)$$

Similarly $1 - L_i$ is the probability of making two right choices and one left choice plus the probability of making one right choice and two left choices.

$$1 - L_i = 3PI_i^2(1 - PI_i) + 3PI_i(1 - PI_i)^2 \qquad (2)$$

These equations have the solution:

$$PI_i = 1/2 \pm 1/6\sqrt{3(4L_i - 1)} \qquad (3)$$

Recall that PI is the probability that a subject will make his dominant choice on a given pair of gambles. A subject who had a PI value of .67 or larger (two standard deviations above the chance level) was accepted for further analysis. In order to evaluate an individual's consistency, it is necessary to know the probability (P_i) that the individual's dominant choice will appear in the reduced matrix form of the data. This is the probability that he made his dominant choice three times or that he made his dominant choice twice in any of three Bernouilli sequences.

$$P_i = PI_i^3 + 3PI_i^2(1 - PI_i) \qquad (4)$$

P_i is the required estimate of the individual's consistency of behavior independent of any of the four expec-

tation theories.

The next step is the evaluation of the consistency of the individuals under restrictions imposed by each of the expectation theories.

1) EU theory. EU theory involves the assumption that an individual will try to maximize the product of the actual probability of winning and the subjective value of the prize. Examination of Tables 1 to 4 reveals that the order of presentation of gambles is such that the probability of winning decreases while the prize value remains constant. Thus, the subjective value should also remain the same. The EU value will, therefore, decrease in the same ratio as the EV value. As can be seen from row seven in Table 1, a point exists where all pairs below that point, EV's and EU's on the left side are greater than those on the right. Since there are only two possible entries in the table (0 and 1) any two scores can form only four different patterns:

0	0	1	1
0'	1'	1'	0 '

Let a latent pattern be one that represents a person's real preferred set of two choices and let a manifest pattern be

the pattern occurring in the reduced matrix. The only admissible latent patterns are: $\begin{smallmatrix}0\\0\end{smallmatrix}$, $\begin{smallmatrix}1\\1\end{smallmatrix}$, $\begin{smallmatrix}0\\1\end{smallmatrix}$, since the pattern $\begin{smallmatrix}1\\0\end{smallmatrix}$, referred to as a violating pattern, indicates that the individual has made one of his choices in a way that does not maximize his EU value. The latter result follows from the fact that the EU value is continually decreasing for the left side gambles less than for the right side gambles. Therefore, if the right side originally has a higher EU value, the only permissible change in preference would be from right to left $\left(\begin{smallmatrix}0\\1\end{smallmatrix}\right)$.

Let $\underline{p}_i$ be the probability that a particular manifest (i.e., observed) pattern occurs in the reduced data matrix when a given latent pattern is the person's real preferred choice pattern. Let $\underline{q}_i$ be the probability that the manifest choice does not correspond to the latent choice. Table 6 is a reproduction of a table in Coombs and Bezembinder (1964) showing (in terms of $\underline{p}_i$ and $\underline{q}_i$), the conditional probability that a particular manifest pattern is observed when a given latent pattern is present. To understand this table, examine the first entry, the one corresponding to the $\begin{smallmatrix}0\\0\end{smallmatrix}$ manifest pattern and the $\begin{smallmatrix}0\\0\end{smallmatrix}$ latent pattern. Both top and bottom entries are 0. This means that the right hand choice is

Table 6

Conditional Probability That a Particular Manifest Pattern is Observed Given the Presence of a Particular Latent Pattern

		Manifest Pattern			
		$\begin{matrix}0\\0\end{matrix}$	$\begin{matrix}1\\1\end{matrix}$	$\begin{matrix}0\\1\end{matrix}$	$\begin{matrix}1\\0\end{matrix}$
Latent Pattern	$\begin{matrix}0\\0\end{matrix}$	$\underline{p}_i^2$	$\underline{q}_i^2$	$\underline{p}_i\underline{q}_i$	$\underline{p}_i\underline{q}_i$
	$\begin{matrix}1\\1\end{matrix}$	$\underline{q}_i^2$	$\underline{p}_i^2$	$\underline{p}_i\underline{q}_i$	$\underline{p}_i\underline{q}_i$
	$\begin{matrix}0\\1\end{matrix}$	$\underline{p}_i\underline{q}_i$	$\underline{p}_i\underline{q}_i$	$\underline{p}_i^2$	$\underline{q}_i^2$

preferred for both entries. The conditional probability that the two pairs agree is $\underline{p}_i \times \underline{p}_i = \underline{p}_i^2$. Patterns $\begin{matrix}0\\0\end{matrix}$ and $\begin{matrix}1\\1\end{matrix}$ are defined as compatible because these patterns indicate no change in choice preference. Pattern $\begin{matrix}0\\1\end{matrix}$ is defined as a confirming pattern because this pattern indicates a choice change in keeping with SEU assumptions, and $\begin{matrix}1\\0\end{matrix}$ is defined as a violating pattern because this indicates a choice change that violates the assumptions of SEU theory.

Let T_i be the proportion of latent compatible patterns for subject i. Since there are no violating latent patterns, $1-T_i$ is the proportion of latent confirming patterns. The probability A_i of obtaining a compatible pattern in the reduced data matrix of individual i is the probability of obtaining the compatible pattern $\begin{smallmatrix}0\\0\end{smallmatrix}$ or $\begin{smallmatrix}1\\1\end{smallmatrix}$ given that the latent pattern is a latent compatible pattern ($(\underline{p}_i^2 + \underline{q}_i^2)T_i$) plus the probability of getting a compatible pattern given that the latent pattern is not compatible ($2\underline{p}_i\underline{q}_i(1-T_i)$).

$$A_i = (\underline{p}_i^2 + \underline{q}_i^2)T_i + 2\underline{p}_i\underline{q}_i(1-T_i) = r/N \qquad (5)$$

In the above equation, r, s, t and N are equal respectively to the number of compatible, manifest confirming, manifest violating, and total number of patterns observed in the individual's reduced data matrix. Similarly the probability (B_i) of a confirming pattern being manifest is

$$B_i = \underline{p}_i\underline{q}_i\, T_i + \underline{p}_i^2(1-T_i) = s/N \qquad (6)$$

Equations (5) and (6) may be solved for $\underline{p}_i$ and T_i. Remembering that $\underline{p}_i$ is the probability that the observed pattern of two scores agrees with the individual's preferred choice, it can be employed as an estimate of the individual's consistency of behavior under restrictions of EU theory.

2) SEV theory. SEV theory involves the subjective value of probability and real value of prize. If Tables 1 to 4 are read along rows of constant probability, analogous patterns to those examined for EU theory will be observed. In this instance the pattern 1 0 is the violating pattern. Thus, the same procedure may be carried out for estimating p_i using row patterns instead of column patterns. The values of r, s, and t change, however, (r+s+t = 2 x 8 = 16).

3) SEU theory. The patterns involved in testing SEU theory are all of the second order minors of the reduced data matrix. A second order minor is any combination of four elements from a larger array such that the elements in each respective row of the minor are taken from the same row in the matrix and the elements from each respective column are taken from the same column in the original matrix. The following is a second order minor with elements A, B, C, and D; $\begin{vmatrix} A & B \\ C & D \end{vmatrix}$.

One of the Bezembinder and Coombs theorems (theorem 5 in Appendix I) states that if the assumptions of SEU theory are accepted and if the entries of the minor are numerical ratios of expectations, then the determinant of every second order minor will equal zero (AD - BC = 0). If 0's and 1's are the only entries in the minors then there are 2^4 or 16

possible second order minor patterns. If the determinants must equal zero then two of these patterns are inadmissible or violating: $\begin{matrix}10\\01\end{matrix}$ and $\begin{matrix}01\\10\end{matrix}$ (since AD - BC $\neq$ 0). The remaining 14 of these patterns are of two types. A pattern is compatible if given any three elements of the pattern there is no constraint on the value of the last element of the pattern to make the determinant equal to zero. A pattern is either confirming or violating if there exists at least one particular subset of three elements of the pattern for which the fourth element is predicted by theory. If the fourth element corresponds to theoretical predictions, the pattern is called confirming, if not, the pattern is called violating. A similar consideration of probabilities as that made for EU theory provides the set of equations:

$$A_i = (\underline{p}_i^4 + 4\underline{p}_i\underline{q}_i^2 + \underline{q}_i^2)T_i + (3\underline{p}_i^3\underline{q}_i + \underline{p}_i\underline{q}_i^3)(1-T_i)$$
$$= r/N \qquad (7)$$

$$B_i = 4(\underline{p}_i^3\underline{q}_i + \underline{p}_i\underline{q}_i^3)T_i + \underline{p}_i^4 + 6\underline{p}_i\underline{q}_i^2 + \underline{q}_i^4)(1-T_i)$$
$$= s/N \qquad (8)$$

These may be solved for $\underline{p}_i$ which provides an estimate of the individual's consistency in behavior under SEU theory.

4) EV theory. In the reduced data matrix there are 32 predictions of either a 0 or a 1. Two of these involve equal expectation values for both left and right members of the pair and hence using only the assumption of EV theory, it is not possible to predict which of the two choices the individual will prefer. The expectation and variance of the number of times these predictions will fail, given p_i, are:

$$E(v_i) = 30q_i \tag{9}$$

$$VAR(v_i) = 30\ p_iq_i \tag{10}$$

In the case of EU, SEV, and SEU theories, the consistency value p_i according to a particular theory is compared with the value P_i of the consistency of the individual independent of any theory. An individual is accepted as supporting a particular theory if p_i is greater than P_i. That is, the individual's consistency estimate under assumptions of a given expectation theory is larger than the consistency estimate under assumptions that are independent of any expectation theory. In the case of EV theory, the number of violations of the requirements of the theory is compared with the expected value of violations (viol). A Z ratio ((viol - 30 q_i)/ sqrt (30 p_iq_i)) is formed and EV is accepted at the 05 per-

cent level of significance.

The second major step in the data analysis was testing the hypothesis that high anxious-high defensive and low anxious-low defensive subjects conformed more closely to the four expectation theories than low anxious-high defensive and high anxious-low defensive subjects.

The two personality questionnaires were scored in the manner prescribed by Alpert and Haber (1960) and Crowne and Marl owe (1960). A subject was designated high or low defensive and high or low anxious on the basis of whether his score was above or below the median score for the group on the questionnaires. In order to explore the possibility that various sex and personality patterns would differentially conform to the four theories, the whole group and then the male and female subjects were classified into: high and low anxious, high and low defensive, low anxious-low defensive, high anxious-high defensive, low anxious-high defensive, high anxious-low defensive. Chi square and binomial tests were then performed to determine whether there was any differential conformity to the four theories.

RESULTS

Table 7 shows the proportion of 3/0 splits (RL_i), the average probability of an individual making his dominant choice on any pair of gambles (PI_i), and the individual's consistency estimate without regard to theory (P_i). The latter (P_i), is equivalent to the probability that the individual's dominant choice will appear in the reduced data matrix. Three subjects S19, S46, and S70 were eliminated from further analyses because their PI_i was below the criterion for minimum consistency (PI less than .67). The proportion of latent compatible patterns (T) calculated separately under EU, SEV, and SEU theory for each subject appears in Table 8.

The estimate of the individual's consistency level (P) without theoretical assumptions critical to expectation theory, the consistency level assuming EU theory (P_{EU}), the consistency assuming SEV theory (P_{SEV}), and the consistency assuming SEU theory (P_{SEU}) are presented in Table 9. Table 10 presents the results of the Coombs and Bezembinder method of testing whether a significant number of the subject's choices violated EV theory. On the basis of these data, it was determined that EV theory was rejected for 57 subjects, EU theory was rejected for 31 subjects SEV theory was rejected for 26 subjects and SEU theory was rejected for 14 subjects. Bartholomew tests of homogeneity for

Table 7. The Proportion of 3/0 Splits (RL), the Average Probability of an Individual Making his Dominant Choice on any Pair of Gambles (PI) and the Individual's Consistency Estimate Independent of Any Expectation Theory (P) for 77 Subjects

Subject	RL	PI	P
1	.50	.79	.885
2	.66	.87	.952
3	.53	.81	.902
4	.72	.90	.969
5	.34	.68	.754
6	.66	.87	.952
7	.50	.79	.885
8	.56	.82	.917
9	.81	.93	.987
10	.34	.68	.754
11	.72	.89	.969
12	1.00	1.00	1.000
13	1.00	1.00	1.000
14	.84	.94	.991
15	.63	.85	.942
16	.84	.94	.991
17	.78	.92	.982
18	1.00	1.00	1.000
19	.28	.60	.651
20	.75	.91	.976
21	.75	.91	.976
22	.91	.97	.997
23	.41	.73	.819
24	1.00	1.00	1.000
25	.78	.92	.982
26	.72	.90	.969
27	.78	.92	.982
28	.97	.99	.999
29	.91	.97	.997
30	.50	.79	.885
31	.50	.79	.885
32	.72	.90	.969
33	.91	.97	.997
34	.81	.93	.987
35	.97	.99	.999
36	.59	.84	.930

Table 7. (continued)

Subject	RL	PI	P
37	.72	.90	.969
38	.53	.81	.902
39	1.00	1.00	1.000
40	1.00	1.00	1.000
41	.56	.82	.917
42	.81	.93	.987
43	.84	.94	.991
44	.84	.94	.991
45	.44	.75	.844
46	.25	.51	.515
47	.91	.97	.997
48	.97	.99	.999
49	.84	.94	.991
50	.91	.97	.997
51	.47	.77	.866
52	.56	.82	.917
53	.72	.90	.969
54	.50	.79	.885
55	.66	.87	.952
56	.38	.70	.789
57	.81	.93	.987
58	.59	.84	.930
59	.75	.91	.976
60	.78	.92	.982
61	.91	.97	.997
62	.78	.92	.982
63	.53	.81	.902
64	.63	.85	.942
65	.88	.96	.995
66	.47	.77	.866
67	.53	.81	.902
68	.97	.99	.999
69	.94	.98	.999
70	.28	.60	.651
71	.78	.92	.982
72	.69	.88	.961
73	.63	.85	.942
74	.59	.84	.930
75	.81	.93	.987
76	.78	.92	.982
77	.78	.92	.982

Table 8. Proportion of Latent Compatible Patterns (T) Calculated Separately Under the Assumptions of EU, SEV, and SEU Expectation Theories.

Subject	EU	SEV	SEU
1	.37	1.00	.86
2	.68	.85	.00
3	1.00	.94	.88
4	1.00	1.00	.88
5	.46	.77	.78
6	.54	.75	.64
7	.50	1.00	.00
8	.30	1.00	.76
9	.44	1.00	.88
10	1.00	.68	.43
11	.49	.94	.88
12	1.00	1.00	1.00
13	1.00	1.00	1.00
14	.71	1.00	.88
15	.64	1.00	1.00
16	.46	1.00	.88
17	1.00	1.00	1.00
18	1.00	1.00	1.00
19			
20	.54	.56	.59
21	.71	.94	.88
22	1.00	.56	.88
23	.56	1.00	0.00
24	1.00	1.00	1.00
25	.54	1.00	.69
26	.52	.50	.55
27	.49	.94	.88
28	.43	1.00	1.00
29	.62	1.00	.88
30	.64	.85	.00
31	.25	.91	.00
32	1.00	1.00	.88
33	.35	.94	.88
34	.88	.88	.84
35	.76	1.00	1.00
36	.50	1.00	.72
37	.47	.94	.88

Table 8. (continued)

Subject	EU	SEV	SEU
38	.59	.84	.57
39	1.00	1.00	1.00
40	1.00	1.00	1.00
41	.46	.81	0.00
42	.56	.88	.84
43	.66	1.00	.84
44	.39	.56	No Convergence
45	.63	.56	.76
46			
47	.49	.94	.88
48	1.00	1.00	.88
49	.75	1.00	1.00
50	.43	1.00	1.00
51	.51	.69	1.00
52	.92	.69	.73
53	1.00	.49	.69
54	.45	.75	1.00
55	.31	.94	0.00
56	.46	.81	.64
57	.86	.93	.73
58	.42	.81	.73
59	.67	.44	.99
60	.75	1.00	.59
61	.45	1.00	1.00
62	.46	1.00	.84
63	.72	.94	0.00
64	.46	.81	.73
65	.48	.97	.73
66	.58	.82	.64
67	.56	.91	.61
68	1.00	.93	.68
69	.44	.93	.88
70			
71	.59	.88	.88
72	.32	1.00	.79
73	1.00	1.00	.00
74	.63	1.00	.87
75	.28	1.00	.64
76	.52	.85	.84
77	1.00	1.00	.64

ordered alternatives (Bartholomew, 1959) were made to test for the monotonicity of the number of rejections in the SEU-SEV-EV sequence and the SEU-EU-EV sequence. These were both significant at beyond the .01 level of confidence. (Since no statistical test incorporating the non-independence of the data was available, this test was used in spite of the fact that some of the individuals obeyed more than one theory.)

Table 11 shows the number of high and low anxious and high and low defensive subjects (based on a median split of scores on the personality questionnaires) obeying each of the four expectation theories.[1] Chi square tests conducted separately for males, females, and the total group revealed that fewer high defensive males than low defensive males obeyed SEV theory (p less than .05). It was also noted that for all four expectation theories high anxious subjects were either equally or more frequently rejected than low anxious subjects, but none of these differences reached statistical significance.

---

[1]Eight individuals falling right at the median on the anxiety scale were dropped from classification on the anxiety variable in this and subsequent portions of the analysis. Twelve individuals falling right at the median on the defensiveness questionnaire and five additional individuals who failed to complete the defensiveness questionnaire properly were dropped from classification on the defensiveness variable in this and subsequent portions of the analysis.

Table 9. Estimate of the Subjects' Consistency Level Independent of Any Theoretical Assumptions Critical to Expectation Theory (P), and Under the Assumptions of EU, SEV, and SEU Theories (P_{EU}, P_{SEV}, P_{SEU}).

Subject	P	P_{EU}	P_{SEV}	P_{SEU}
1	.885	.684	.875	.902
2	.952	.973	.922	.500
3	.902	.490	1.000	.999
4	.969	.484	.938	.999
5	.754	.849	.914	.864
6	.952	1.000	1.000	1.000
7	.885	.629	.865	.500
8	.917	.607	.750	.884
9	.987	1.000	.938	.999
10	.754	.500	.794	.857
11	.969	1.000	1.000	.999
12	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000
14	.991	1.000	.938	.999
15	.942	.852	.933	.500
16	.991	.964	.938	.999
17	.982	1.000	1.000	1.000
18	1.000	1.000	1.000	1.000
19				
20	.976	1.000	1.000	1.000
21	.976	.731	1.000	.999
22	.997	.938	1.000	.999
23	.819	.782	.750	.500
24	1.000	1.000	1.000	1.000
25	.982	.900	.813	.999
26	.969	.589	1.000	1.000
27	.982	1.000	1.000	.999
28	.999	1.000	1.000	1.000
29	.997	.986	.938	.999
30	.885	.714	.711	.500
31	.885	.500	.839	.500
32	.969	.500	.938	.999
33	.997	1.000	1.000	.999
34	.987	.990	1.000	.970
35	.999	1.000	1.000	1.000

Table 9. (continued)

Subject	P	P_{EU}	P_{SEV}	P_{SEU}
36	.930	.714	1.000	.999
37	.969	1.000	1.000	.999
38	.902	.795	.922	.929
39	1.000	1.000	1.000	1.000
40	1.000	1.000	1.000	1.000
41	.917	.774	.820	.500
42	.987	1.000	1.000	.999
43	.991	.853	.933	.999
44	.991	.980	1.000	.999
45	.844	.877	1.000	No Convergence
46				
47	.997	1.000	1.000	.999
48	.999	1.00	1.000	1.000
49	.991	1.000	1.000	1.000
50	.997	1.000	1.000	1.000
51	.866	.742	.914	.889
52	.917	.810	1.000	.827
53	.969	1.000	1.000	1.000
54	.885	.500	.854	.500
55	.952	1.000	1.000	1.000
56	.789	.980	1.000	.999
57	.987	.939	1.000	.999
58	.930	.916	.928	.933
59	.976	1.000	1.000	1.000
60	.982	1.000	1.000	1.000
61	.997	1.000	.933	.999
62	.982	1.000	1.000	1.000
63	.902	1.000	1.000	.999
64	.942	1.000	1.000	.999
65	.995	1.000	1.000	1.000
66	.866	.734	.866	.945
67	.902	.965	1.000	.999
68	.999	1.000	.938	.999
69	.999	1.000	1.000	.999
70				
71	.982	.772	1.000	.999
72	.961	.500	.797	.500
73	.942	1.000	.938	.999
74	.930	.746	.726	.871
75	.987	1.000	.933	.999
76	.982	1.000	.922	1.000
77	.982	1.000	1.000	1.000

Table 10. Results of the Coombs and Bezembinder Method of Testing Whether a Subject Should be Rejected for EV Theory (* indicates significance at the .01 level; ** indicates significance at the .001 level)

Subject	Number of Violations of EV Theory	Z Value
1	11	4.32**
2	9	6.49**
3	17	8.63**
4	16	15.99**
5	5	-1.01
6	1	-0.37
7	13	5.46**
8	13	6.95**
9	7	10.72**
10	11	1.54
11	3	2.21*
12	15	0.00
13	15	0.00
14	4	7.31**
15	9	5.67**
16	5	9.27**
17	9	11.68**
18	15	0.00
19		
20	0	-0.85
21	11	12.35**
22	10	32.75**
23	7	0.74
24	9	0.00
25	9	11.68**
26	13	12.81**
27	6	7.54**
28	5	50.15**
29	9	29.44**
30	13	5.46**
31	11	4.32**
32	10	9.63**
33	6	19.53**
34	7	10.72**
35	11	110.45**
36	10	5.66**

Table 10. (continued)

Subject	Number of Violations of EV Theory	Z Value
37	6	5.39**
38	8	3.10**
39	9	0.00
40	9	0.00
41	6	2.32**
42	6	9.10**
43	13	24.93**
44	3	5.35**
45	6	0.66
46		
47	6	19.53**
48	9	90.35**
49	5	9.27**
50	5	16.22**
51	10	3.20**
52	7	2.98**
53	6	5.39**
54	16	7.18**
55	3	1.35
56	3	-1.49
57	14	22.06**
58	7	3.51**
59	0	-0.85
60	5	6.16**
61	4	12.92**
62	6	7.54**
63	4	0.65
64	3	0.98
65	1	2.05*
66	9	2.66**
67	10	4.33**
68	14	140.60**
69	4	19.76**
70		
71	13	17.20**
72	13	11.23**
73	4	1.76*
74	13	7.81**
75	5	7.48**
76	4	4.78**
77	15	19.96**

Table 11. The Number of Anxious and the Number of Defensive Subjects (median split with persons scoring the median value dropped from classification) Satisfying Each of the Four Expectation Theories.

		MALE				FEMALE				TOTAL			
Expec. Theory	Total Satis.	High Anx.	Low Anx.	High Def.	Low Def.	High Anx.	Low Anx.	High Def.	Low Def.	High Anx.	Low Anx.	High Def.	Low Def.
SEU	60	17	22	16	20	7	8	7	4	24	30	23	24
SEV	48	13	17	9	19	6	6	5	4	19	23	14	23
EU	43	12	14	10	14	6	7	6	4	18	21	16	18
EV	17	2	6	5	4	4	4	5	2	6	10	10	6

Table 12. Classification of Subjects Satisfying Each of the Four Expectation Theories by Extreme Personality Types (Upper and Lower Quartile Split)

Expectation Theory	Total Satisfying	High Anxious	Low Anxious	High Defensive	Low Defensive
SEU	60	13	13	15	16
SEV	48	12	9	8	17
EU	43	11	7	8	13
EV	17	3	4	4	4

It seemed possible, however, that the masking effects of borderline anxious and borderline defensive individuals could have confused the results. In order to overcome this possible shortcoming, a subject was therefore redefined as high or low with respect to either of the two personality traits if his score on the particular personality questionnaire fell within the upper or lower quartile of the total distribution of scores. The number of these newly defined personality types obeying each of the four expectation theories appears in Table 12. It was determined that fewer high defensive subjects obeyed SEV theory than did low defensive subjects ($p < .01$). This result was consistent with the finding reported for males under the original definition of high and low personality groupings. No new significant differences between personality groups satisfying the expectation theories emerged in this re-analysis, however.

Table 13 presents the number of individuals in each of the four personality subgroups (low anxious - low defensive, high anxious - high defensive, low anxious - high defensive and high anxious - low defensive, based on a median split of the scores on the personality questionnaires) obeying each of the expectation theories. Since for all four expectation theories there were either fewer or an equal number of low anxious - low defensive males than high anxious - low defensive males and

Table 13. Classification of Subjects Satisfying Each of the Four Expectation Theories by Personality Types (median split with persons scoring at the median value dropped from classification).

		MALE				FEMALE				TOTAL			
		High Def.		Low Def.		High Def.		Low Def.		High Def.		Low Def.	
Expec. Theory	Total Satis.	High Anx.	Low Anx.	High Anx.	Low Anx.	High Anx.	Low Anx.	High Anx.	Low Anx.	High Anx.	Low Anx.	High Anx.	Low Anx.
SEU	60	3	12	12	6	4	3	1	3	7	15	13	9
SEV	48	1	7	11	6	3	2	1	3	4	9	12	9
EU	43	2	7	8	5	4	2	1	3	6	9	9	8
EV	17	0	4	2	2	3	2	1	1	3	6	3	3

fewer high anxious - high defensive males than low anxious - high defensive males, it was decided to do an ad hoc statistical analysis of the relationships among these subgroups. Tests of the difference between the proportions of subjects obeying the four expectation theories revealed that fewer males who were either high anxious - high defensive or low anxious - low defensive obeyed SEU and SEV theory than did males who were either low anxious - high defensive or high anxious - low defensive ($p < .05$).

The numbers of high and low anxious and the numbers of high and low defensive subjects with scores in the upper or lower quartile of the distribution of scores on the PI consistency criterion are shown in Table 14. The difference in the proportions of high anxious and low anxious subjects falling into the high PI group and those proportions falling into the low PI group was not statistically significant (chi square test). A chi square test also failed to reveal any significant differences between the proportions of high defensive and low defensive subjects falling into the high PI groups and those proportions falling into the low PI groups.

Table 15 presents the number of male and female subjects who do and do not satisfy each of the four expectation theories. Chi square tests failed to reveal any significant differences

between the number of males and females who did satisfy each of the four expectation theories and the number who did not.

Table 14. The Number of High and Low Anxious and High and Low Defensive Subjects Falling into the Upper and Lower Quartiles on the Coombs and Bezembinder PI Consistency Estimate

	LOW PI	HIGH PI
High Anxious	11	8
Low Anxious	7	8
High Defensive	6	11
Low Defensive	11	6

Table 15. The Number of Male and Female Subjects Satisfying Each of the Four Expectation Theories.

	M A L E		F E M A L E	
	Satisfy	Do Not Satisfy	Satisfy	Do Not Satisfy
SEU	45	8	15	6
SEV	36	17	12	9
EU	30	23	13	8
EV	9	44	8	13

DISCUSSION

The proportion of subjects in the present study rejected for EV, EU, SEV and SEU theory respectively are .77, .42, .35 and .19. The hypothesis of monotonicity in the number of rejections for the two sequences, SEU-SEV-EV and SEU-EU-EV, was accepted on the basis of Bartholomew (1959) tests of homogeneity for ordered alternatives which were significant at beyond the nominal .01 level of confidence for both sequences. (Since the data unfortunately did not meet the assumptions of independence among components required of Bartholomew's tests, the "nominal" levels in the present instance only provide approximations of the "true" significance levels.)

The proportion of subjects in the present study rejected for EV, EU, SEV and SEU theory may be compared with the respective proportions .94, .24, .33 and .09 reported by Coombs and Bezembinder (1964). Thus, in both studies a relatively large proportion of subjects was found to satisfy SEU theory, a small proportion was found to satisfy EV theory and intermediate proportions were found to satisfy SEV and EU theory. This pattern of findings in the two studies was similar despite differences in the type of subject used. The present study used university students only whereas university students comprised only part of the subject population for the Coombs and Bezembinder study. The remainder of Coombs and

Bezembinder's subjects were adults from a low socio-economic area. These parallel findings for ostensibly diverse subjects suggest that these proportions may be generalizable to the population as a whole.

The hypothesis that a higher proportion of females than males would obey the four expectation theories was rejected because no significant differences were found between the proportion of males and females satisfying each of the four expectation theories.

One of the major hypotheses of this study was that more low anxious-low defensive and high anxious-high defensive subjects would obey the four expectation theories than high anxious-low defensive and low anxious-high defensive subjects. Since the proportions obeying the expectation theories were the reverse of those predicted, this hypothesis was rejected.

It was noted that fewer high anxious than low anxious males (based on the median split) conformed to each of the four expectation theories. Since none of the associated proportions reached statistical significance, it is probable that the finding under the original definition of high and low anxious was the result of the smaller number of high anxious subjects (30) than low anxious subjects (36) in the population tested. This discrepancy in number arose from the elimination of subjects whose score tied at the median value for the questionnaire. When high

and low anxious subjects were redefined on the basis of upper and lower quartile divisions on the questionnaire scores, this result reverses direction, but not significantly so. If the finding that fewer high anxious subjects obeyed the expectation theories is not entirely accounted for by the discrepancy between the number of high and low anxious subjects in the population, the reversal when a quartile division of the questionnaire scores is employed raises the possibility that anxiety may have a non linear effect on the individual's potentiality to satisfy the expectation theories. That is, high and low anxiety might inhibit types of rational behavior required to satisfy the expectation theories: whereas intermediate anxiety might initiate behavior required for the satisfaction of the expectation theories.

There could be several possible explanations for the general inconclusiveness of these results. The manner and speed with which the subjects completed the task presents one possibility. The subjects completed the task in a very short period of time (about 30 minutes). It was, at first, feared that this might have produced data of questionable reliability. These fears were partially allayed, however, by the degree of interest and personal involvement expressed by the subjects at the conclusion of the experiment. It was decided, therefore, to accept the data as a fair test of the hypotheses if few subjects needed to be dropped from the analysis on the basis of the Coombs and Bezembinder

consistency criterion. Since only three out of seventy-seven subjects were eliminated on this basis, the data were deemed acceptable for further analysis.

A second possible explanation for the non significant results may be that the two personality tests, the Alpert and Haber Test Anxiety Scale and the Crowne and Marlowe Defensiveness Scale, were not valid measures of defensiveness and anxiety. There have been relatively few studies in the literature dealing with either of these two scales and it is not altogether clear whether the two scales measure what they purport to measure. These two personality tests were chosen, however, because their reported reliabilities were high and because Kogan and Wallach (1964) used them in the study that led to the formulation of the first two hypotheses tested in this experiment.

These two hypotheses were based on the assumption that the type of consistency in behavior noted by Kogan and Wallach was the same as the type of consistency in behavior required by the Coombs and Bezembinder method of testing expectation theories. The failure of this study to confirm the experimental hypotheses may be due, in part, to the untenability of this assumption. Kogan and Wallach reported that certain personality types performed consistently (as far as risk taking behavior was concerned) across a series of qualitatively different risk taking situations (actual gamble, hypothetical gamble, and skill game). Coombs and

Bezembinder, however, require a consistency of behavior across a series of risk taking situations that differ only quantitatively in the amount won and the probability of winning. Consistency in behavior across a series of different situations may not necessarily imply consistency in behavior within a series of modifications of the same situation. Thus, the consistency in behavior reported by Kogan and Wallach would not necessarily imply the type of consistency required by Coombs and Bezembinder for satisfaction of the expectation theories.

This study did reveal two statistically significant results with regard to the personality variables. SEV theory was obeyed by fewer high defensive males than low defensive males under the "median split" definition of defensiveness and fewer high defensive males and females than low defensive males and females under the "quartile split" definition of defensiveness. Furthermore, fewer males who were either low anxious-low defensive or high anxious-high defensive obeyed SEU and SEV theory than males who were either low anxious-high defensive or high anxious-low defensive. These results provide no sound basis on which to state the exact effect of the personality variables on the satisfaction of expectation theories, but they suggest that these personality variables might indeed play a role in governing this type of behavior. It is therefore the conclusion of this study that

further research directed toward discovery of personality correlates of gambling behavior would be fruitful.

Two major recommendations can be made regarding future research in this area. First, a new method of testing expectation theories of gambling recently developed by Tversky (1965) might prove to be a more valid way of testing the expectation models of behavior. Tversky's method appears to improve upon the Coombs and Bezembinder method for several reasons: it is a more demanding test since there are no gambling patterns that are not tests of the expectation theory; additivity of the subjective probability and utility components is tested directly rather than assumed which in turn permits the separate evaluation of subjective probability and utility; and it is possible to evaluate a utility-for-gambling-index.

The power of Tversky's methodology and the inconclusiveness of the results of the present study which may, in part, be due to the fact that two distinct types of consistency (as mentioned above) are involved in the study of risk taking behavior, suggest that research on the role of personality variables in decision making could take two distinct directions. Both of these directions could be tested by the Tversky technique. The direction taken by Kogan and Wallach which relates personality variables to propensity for risk could thus be examined by the Tversky technique in which the utility-for-gambling-index could be directly related

to a host of personality variables. The direction taken in this study was to relate personality variables to rationality of decision (i.e., satisfaction of some expectancy theory). The Tversky technique would make possible the study of the interrelation of these two aspects of decision making to personality variables.

The second recommendation is that this type of experiment might yield clearer results if the subjects were trained for a period of time and run individually rather than as a group through a real gambling situation. If the group situation must be used, it is recommended that a mechanical device such as a slide projector for the presentation of gambles be employed in order to pace the subjects through the task.

If these recommendations were followed, the present data suggest that meaningful relationships between personality variables and expectation theories of gambling behavior might indeed be discovered.

SUMMARY AND CONCLUSIONS

The general purpose of this study was to examine one approach to the study of the relationship of personality variables to expectation theories of gambling. The Coombs and Bezembinder (1964) method of testing expectation theories of gambling behavior was used to determine how many, among a group of 77 subjects, obeyed each of four expectation theories. These four expectation theories were: EV theory, assuming the maximization of the product of objective prize values and actual probabilities of winning; EU theory, assuming maximization of the product of subjective prize values and actual probabilities of winning; SEV theory, assuming the maximization of the product of objective prize values and subjective probabilities of winning; and SEU theory, assuming the maximization of the product of subjective value of the prize and the subjective probability of winning.

The Coombs and Bezembinder method consists of comparing an estimate of an individual's consistency of choices independent of expectation theory assumptions with estimates of consistency under assumptions basic to each of the four expectation theories. A lower value of the consistency estimate under assumptions of a given expectation theory than the value calculated independently of any expectation theory assumptions leads to rejection of that

particular theory as a model for the subject's behavior. The Coombs and Bezembinder technique for determining whether an individual obeys the four expectation theories leads to the prediction of an ordering of the expectation theories with respect to the number of subjects who do not satisfy them.

The procedure in the present study involved the presentation of 96 pairs of one-outcome gambles to 77 subjects in an introductory psychology class. A subject was required on each pair to choose between a gamble combining high risk with a large prize and a gamble combining a low risk with a small prize. It was found that EV theory was rejected for 57 subjects, EU theory for 31 subjects, SEV theory for 26 subjects and SEU theory for 14 subjects. The hypothesis of monotonicity in the number of rejections for the two sequences SEU-SEV-EV and SEU-EU-EV was accepted. A second hypothesis, that a higher proportion of females will obey the expectation theories than will males, was rejected.

The subjects were subdivided into high and low anxious and high and low defensive groups on the basis of scores obtained on the Alpert and Haber Test Anxiety Scale and the Crowne and Marlowe Defensiveness Scale. An examination of the data was sufficient to reject the hypothesis that more low anxious-low defensive and high anxious-high defensive subjects would obey the four expectation theories than would subjects who were either low anxious-high defensive or high anxious-low defensive.

There were, however, some statistically significant results

obtained on the basis of several ad hoc analyses. Fewer high defensive males than low defensive males appeared to obey SEV theory. Furthermore, fewer males who were either high anxious-high defensive or low anxious-low defensive obeyed SEU and SEV theory than did males who were either low anxious-high defensive or high anxious-low defensive. On the basis of these results, it was recommended that further research be conducted on the relationships of personality variables to expectation theories of gambling.

It was noted that the use of the Tversky method of testing expectation theories would permit the simultaneous examination of two approaches to the relationship of personality variables to decision making (personality variables versus propensity for risk and personality variables versus rationality of decision).

Finally, with respect to technique, it was recommended that better ways of assessing personality variables be found and the subjects be fully trained and run individually through the experiment.

BIBLIOGRAPHY

Allais, M., Le comportement de l'homme rationnel deuant le risque. Econometrika, 1953, 21, 503-546.

Alpert R. and Haber, R.N. Anxiety in academic achievement situations. J. Abnorm. Soc. Psychol., 1960, 61, 207-215.

Atkinson, J. W. Motivational Determinants of Risk Taking Behavior. Psychol. Rev., 1957, 64, 359-372.

Atkinson, J. W., Bastian, J. R., Earl, R.W., and Litwin, G. H. The Achievement Motive, Goal Setting and Probability Preferences. J. Abnorm. Soc. Psychol., 1960, 60, 27-36.

Bartholomew, D. J. A Test of Homogeneity for Ordered Alternatives. Biometrika, 1959, 46, 36-48.

Bernouilli, D. Exposition of a new theory on the measurement of risk. Econometrika, 1954, 22, 23-26.

Brody, N. Need Achievement, Test Anxiety, and Subjective Probability of Success in Risk Taking Behavior. J. Abnorm. Soc. Psychol., 1963, 66, 413-418.

Cohen, J. and Hansel, C.E. Experimental risk taking. Jaheb. Psychol. u. Psychotherapie, 1955, 3, 382-388.

Coombs, C. H. A theory of psychological scaling. Bull. Engng. Res. Inst. Univer. Mich., 1952, No. 34.

Coombs, C. H. and Beardsley, D. C. Decision making under uncertainty. In R. M. Thrall, C. H. Coombs, and R. L. Davis (eds.), Decision Processes. New York: 1954, Wiley.

Coombs, C. H. and Bezembinder, T.G.G. Testing expectation theories without measuring utility of subjective probability. Michigan Mathematical Psychology Program, 1965, 2.

Coombs, C. H. and Kormorita, S.S. Measuring utility of money through decisions. Amer. J. Psychol., 1958, 71, 383-389.

Coombs, C. H. and Pruitt, D.G. A study of decision making under risk. Rept. No. 2900-33-T. Willow Run Laboratories, Univ. of Michigan, Ann Arbor, Mich., 1960.

Crowne, D. P. and Marlowe, D. A new scale of social desirability, independent of psychopathology. J. Consult. Psychol., 1960, 24, 349-354.

Davidson, D., Suppes, P., and Siegel, S. Decision Making: An Experimental Approach. Stanford, California: Stanford Univer. Press, 1957.

Edwards, W. Probability preferences among bets with differing expected values. Amer. J. Psychol., 1954a, 67, 56-67.

Edwards, W. The reliability of probability preferences. Amer. J. Psychol., 1954b, 67, 68-95.

Edwards, W. Variance preferences in gambling. Amer. J. Psychol. 1954c, 67, 441-452.

Edwards, W. Theory of decision making. Psychol. Bull., 1954, 51, 380-417.

Edwards, W. Behavioral decision Theory. Ann. Rev. Psychol., 1961, 12, 473-495.

Festinger. Studies in decision: II. an empirical test of a quantitative theory of decision. J. Exp. Psychol., 1943, 32, 411-432.

Fisher, I. The Nature of Capital and Income. New York: Macmillan, 1906.

Kogan and Wallach. Risk Taking: a study in cognition and personality. New York: Holt, Rinehart and Winston, 1964.

Marks, R. W. The effect of probability, desirability and "privilege" on the stated expectations of children. J. Pers., 1951, 19, 332-351.

Mandler, G. and Sarason, S. A study of Anxiety and learning. J. Abnorm. Soc. Psychol., 1952, 47, 166-173.

Mosteller, F. and Nogee, P. An experimental measurement of utility. J. Polit. Econ., 1951, 59, 371-404.

Pruitt, D. G. Pattern and level of risk in gambling decisions. Psychol. Rev., 1962, 69, 187-201.

Rim, Y. Personality and group decision involving risk. Psychol. Rec., 1964, 14, 37-44.

Royden, H. L., Suppes, P. and Walsh, R. A model for the experimental measurement of utility of gambling. Behav. Sci., 1959, 4, 11-18.

Scodel, A., Ratoosh, P. and Minas, J.S. Some personality correlates of decision making under conditions of risk. Behav. Sci., 1959, 4, 19-28.

Shuford, E. H. A comparison of subjective probability for elementary and compound events. Rept. No. 20, The Psychometric Laboratory, Univ. of North Carolina, Chapel Hill, N.C., 1959.

Slovic, P. Assessment of risk taking behavior. Psychol. Bull., 1964, 61, 220-233.

Stone, L. A. The influence of selected individual difference variables upon validity for risk. J. Gen. Psychol., 1964, 70, 29-32.

Suppes, P. and Walsh, K. A non linear model for the experimental measurement of utility. Behav. Sci., 1959, 4, 204-211.

Tversky, A. Additivity analysis of a test of utility theory. Michigan Mathematical Psychology Program, 1965, 2.

APPENDIX I

DISCUSSION OF FIVE THEOREMS ON EXPECTATION THEORY

The following discussion relies heavily on the discussion by Coombs and Bezembinder (1964). Pairs of gambles are examined to see how the ratios of the expectation values of the members of the pair according to a given theory vary as increments are added or subtracted from the probability (P), and the value (V) components of the gambles. The particular gamble of the given pair which has a higher probability to win a smaller amount than the other, will be denoted by the subscript l for left, the other member will be denoted by the subscript r for right. A prime will always denote the addition of an increment to the corresponding unprimed quantity (P' is greater than P). Assume that the subjective probability (W) is strictly monotonic with objective probability and utility (U) for money is strictly monotonic with money. Thus, for any pair of gambles, W_l is greater than W_r and U_l is less than U_r. For each pair of gambles the ratio of their expectations may be formed (i.e. $E_l(W_lU_l) / E_r(W_rU_r) = A$).

There are five theorems dealing with the relationships of these ratios for the various pairs of gambles.

Theorem I: For V_r, V_l, P_r and the change in P_r greater than 0, EV theory requires that:

if $P_lV_l = AP_rV_r$

and if $P_l'V_l = BP_r'V_r$

then A is greater than B.

Interpretation: If we have a pair of gambles as above, the effect of adding a fixed finite increment in probability to both P_l and P_r is to decrease the ratio of the expectation of the gamble on the left to the expectation of the gamble on the right.

Theorem 2: For $V_rV_lP_r$ and the change in V_r greater than 0,

if $P_lV_l = A\ P_rV_r$

and if $P_lV_l' = C\ P_rV_r'$

then C is greater than A.

Interpretation: The effect of adding a fixed finite increment to both V_l and V_r is to increase the ratio of the expectation of the gamble on the left to the expectation of the gamble on the right.

Theorem 3: For U_lU_r greater than 0 and U(V=0)=0 EU theory requires that:

if $P_lU_l = A\ P_rU_r$

and if $P_l'U_l = B\ P_r'U_r$

then A is greater than B.

Interpretation: The effect of adding a fixed finite increment to both P_l and P_r is to decrease the ratio of the

expectation of the gamble on the left to the expectation of the gamble on the right.

Theorem 4: For $V_l V_r$ greater than 0 and $W(P$ greater than 0) is greater than 0, SEV requires that:

if $W_l V_l = A\ W_r V_r$

and if $W_l V_l' = C\ W_r V_r'$

then C is greater than A.

Interpretation: The effect of adding a fixed finite increment to both V_l and V_r is to increase the ratio of the expectation of the gamble on the left to the expectation of the gamble on the right.

Theorem 5: For U (V=0) =0 and W (P greater than 0) is greater than 0, SEU theory requires that:

if $W_l U_l = A\ W_r U_r$

and if $W_l' U_l = B\ W_r' U_r$

and if $W_l U_l' = C\ W_r U_r'$

and if $W_l' U_l' = D\ W_r' U_r'$

then $BC = AD$

Interpretation: The effect of adding fixed finite increments to the U_l and U_r components and the W_l and W_r components is to make the product of the ratios of the expectations of the left and right gambles before adding the increment and

after adding the increment equal to the product of the ratios of expectations of the left and right gambles formed by adding the increment only to the W components and by adding the increment only to the U components.

These theorems suggest that with the correct choice of the P_r, P_l, V_r, V_l, and systematic increments to these values, a particular theorem will predict that the individual will change from consistently preferring the left gamble to consistently preferring the right gamble. If the choice of a left gamble over a right gamble is denoted by the symbol 1 and the other choice by the symbol 0, EV theory will predict that an individual's data matrix (see Table 5) will contain no 1's above a zero and that the cut-off point in the rows between the 1's and the 0's will occur at the point of equal expected value for the members of a pair. EU theory makes the same prediction except that the cut-off point is unknown. In an analogous way, EV and SEV theory predict that no zeros will occur to the right of a 1 in the data matrix with EV theory predicting a specific cut-off point. Finally, the second order minor of the data matrix can be examined in terms of Theorem 5 to see if SEU theory is violated.

List of Symbols Used in the Coombs and Bezembinder Calculation

P - Individual's consistency estimate independent of any expectation theory.

PI - Probability that the subject will make his dominant choice on any pair of gambles.

L - The proportion of times that the individual makes either 3 left choices or three right choices out of three times that a gamble is presented.

$\underline{\hat{p}}$ - The probability that a particular manifest pattern occurs in the reduced data matrix when a given latent pattern is the person's dominant choice pattern (this is equivalent to the consistency estimate under assumption of a given expectation theory).

$\underline{q}$ - The probability that a manifest choice does not correspond to the latent choice.

T - The proportion of latent compatible patterns for the subject.

A - The probability of obtaining a compatible pattern in the reduced data matrix.

B - The probability of obtaining a confirming pattern in the reduced data matrix.

r - Number of compatible patterns in the reduced data matrix.

s - Number of manifest confirming patterns in the reduced data matrix.

t - the number of manifest violating patterns in the reduced data matrix.

N - The total number of patterns in the reduced data matrix that test a given expectation theory.

APPENDIX II

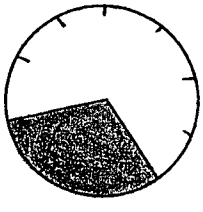
SAMPLE BOOKLET

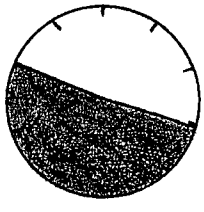
PLEASE DO NOT OPEN THE BOOKLET UNTIL TOLD TO DO SO.

At the top of the booklet indicate whether you are male of female. Do not place your name on the booklet.

Pictured below is a pair of gambles. Each pattern has a spinner that rotates. If the spinner stops on the shaded area of a particular pattern, the prize is the amount of money stated above the pattern. If the spinner stops on the unshaded portion of the pattern, nothing is won or lost.

Place a check inside the gamble which you would choose if you were only allowed to play one of the gambles. On the following





pages are a series of pairs of gambles. Place a checkmark in the number of each pair that you would prefer to play. Make a choice on each pair. Following the series of patterns, there are two questionnaires. Please fill these out according to the instructions at the top of the questionnaire.

At the end of the experiment, ten people will be chosen at random from the class to play one of the gambles on the questionnaire for the cash prize indicated on the booklet. Each of these persons must, however, play the gamble in the way in which he indicated his choice on his booklet.

Listed below are a number of statements concerning personal attitudes towards taking exams. Please underline the word which best describes you personally.

1. Nervousness while taking an exam or test hinders me from doing well.

   Never Seldom Sometimes Often Always

2. I work most effectively under pressure, as when the task is very important.

   Never Seldom Sometimes Often Always

3. In a course where I have been doing poorly, my fear of a bad grade cut down my efficiency.

   Never Seldom Sometimes Often Always

4. When I am poorly prepared for an exam or test, I get upset, and do less well than even my restricted knowledge should allow.

   Never Seldom Sometimes Often Always

5. The more important the examination, the less well I seem to do.

   Never Seldom Sometimes Often Always

6. While I may (or may not) be nervous before taking an exam, once I start, I seem to forget to be nervous.

   Never Seldom Sometimes Often Always

7. During exams or tests, I block on questions to which I know the answers, even though I might remember them as soon as the exam is over.

   Never Seldom Sometimes Often Always

8. Nervousness while taking a test helps me do better.

   Never Seldom Sometimes Often Always

9. When I start a test, nothing is able to distract me.

   Never Seldom Sometimes Often Always

10. In courses in which the total grade is based mainly on one exam, I seem to do better than other people.

    Never Seldom Sometimes Often Always

11. I find that my mind goes blank at the beginning of an exam, and it takes me a few minutes before I can function.

    Never Seldom Sometimes Often Always

12. I look forward to exams.

    Never Seldom Sometimes Often Always

13. I am so tired from worrying about an exam, that I find I almost don't care how well I do by the time I start the test.

    Never Seldom Sometimes Often Always

14. Time pressure on an exam causes me to do worse than the rest of the group under similar conditions.

    Never Seldom Sometimes Often Always

15. Although "cramming" under pre-examination tension is not effective for most people, I find that if the need arises, I can learn material immediately before an exam, even under considerable pressure, and successfully retain it to use on the exam.

Never Seldom Sometimes Often Always

16. I enjoy taking a difficult exam more than an easy one.

Never Seldom Sometimes Often Always

17. I find myself reading exam questions without understanding them, and I must go back over them so that they will make sense.

Never Seldom Sometimes Often Always

18. The more important the exam or test, the better I seem to do.

Never Seldom Sometimes Often Always

19. When I don't do well on a difficult item at the beginning of an exam, it tends to upset me so that I block on even easy questions later on.

Never Seldom Sometimes Often Always

Listed below are a number of statements concerning personal attitudes and traits. Read each item and decide whether the statement is true or false as it pertains to you personally. If it is true place a T beside the item, if it is false place an F.

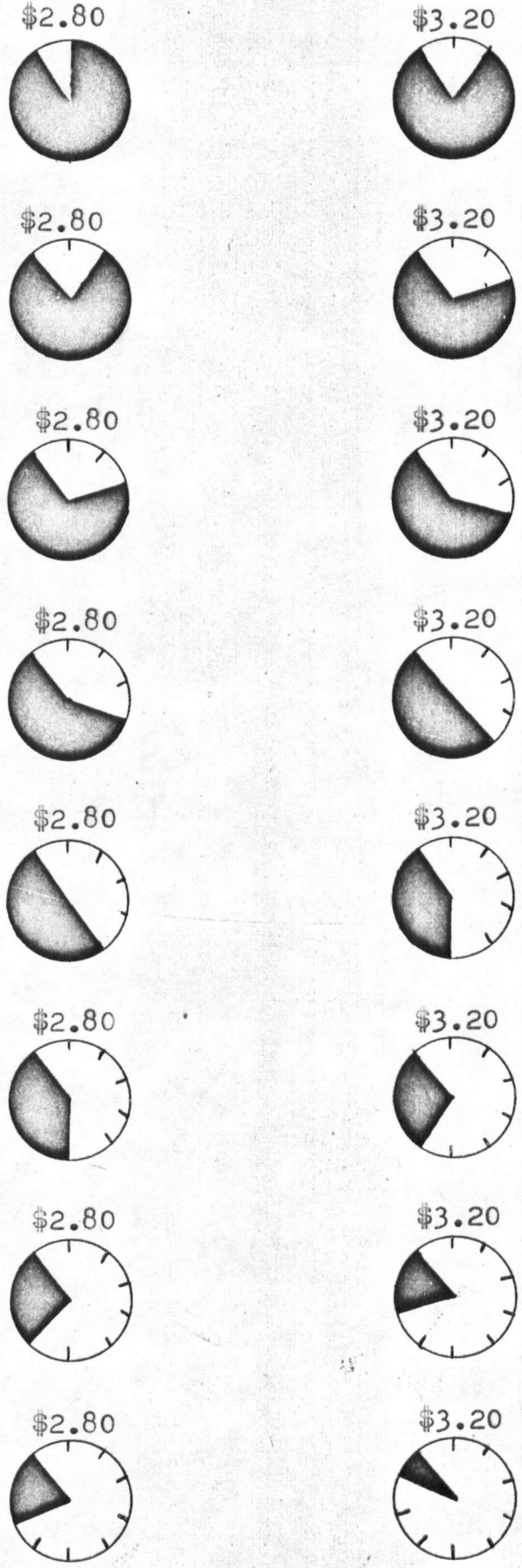
1. Before voting I thoroughly investigate the qualifications of all the candidates.
2. I never hesitate to go out of my way to help someone in trouble.
3. It is sometimes hard for me to go on with my work if I am not encouraged.
4. I have never intensely disliked anyone.
5. On occasion I have had doubts about my ability to succeed in life.
6. I sometimes feel resentful when I don't get my way.
7. I am always careful about my manner of dress.
8. My table manners at home are as good as when I eat out in a restaurant.
9. If I could get into a movie without paying and be sure I was not seen I would probably do it.
10. On a few occasions, I have given up doing something because I thought too little of my ability.
11. I like to gossip at times.
12. There have been times when I felt like rebelling against people in authority even though I knew they were right.

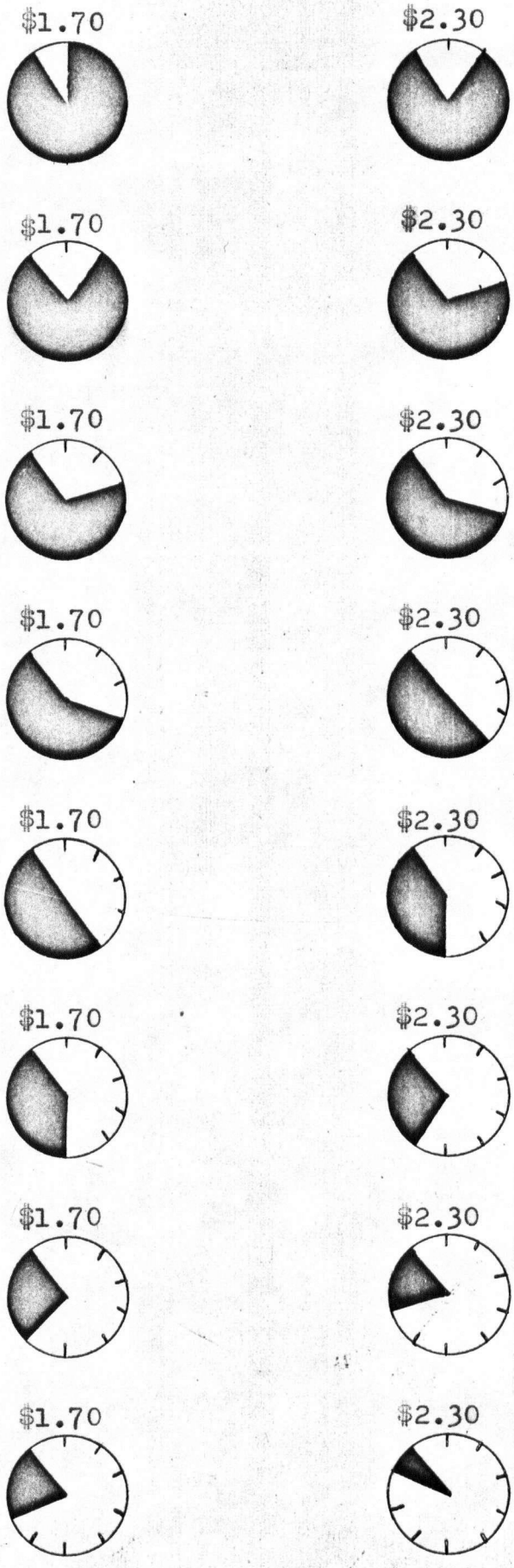
13. No matter who I'm talking to, I'm always a good listener.

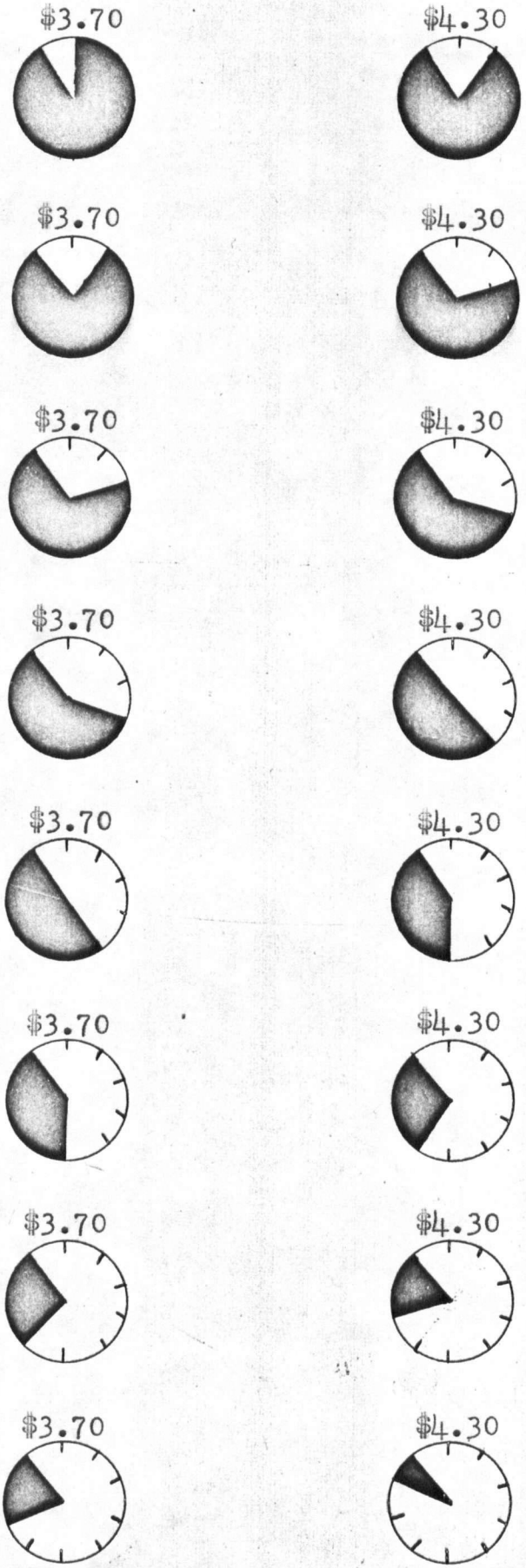
14. I can remember "playing sick" to get out of something.

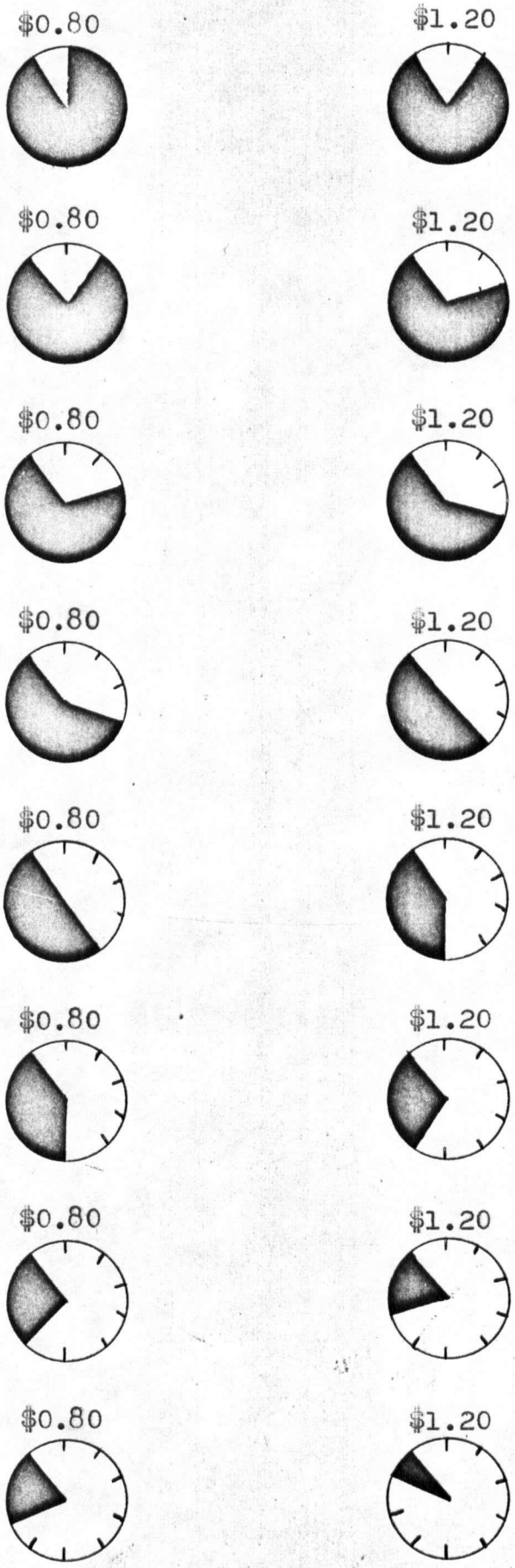
15. There have been occasions when I took advantage of someone.

16. I'm always willing to admit it when I make a mistake.


$2.80
$3.20
$2.80
$3.20
$2.80
$3.20
$2.80
$3.20
$2.80
$3.20
$2.80
$3.20
$2.80
$3.20
$2.80
$3.20


$1.70
$2.30
$1.70
$2.30
$1.70
$2.30
$1.70
$2.30
$1.70
$2.30
$1.70
$2.30
$1.70
$2.30
$1.70
$2.30


$3.70
$4.30
$3.70
$4.30
$3.70
$4.30
$3.70
$4.30
$3.70
$4.30
$3.70
$4.30
$3.70
$4.30
$3.70
$4.30


$0.80
$1.20
$0.80
$1.20
$0.80
$1.20
$0.80
$1.20
$0.80
$1.20
$0.80
$1.20
$0.80
$1.20
$0.80
$1.20