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DECISION — MAKING: THE INFLUENCE OF PROBABILITY PREFERENCE, VARIANCE PREFERENCE AND EXPECTED VALUE ON STRATEGY IN GAMBLING

BY

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Man is continually being confronted with situations in which he must make a decision, i.e. must choose between the alternatives present in a given situation. By the school of economists started by Jeremy Bentham in the second half of the 18th century the aim of all behaviour was stated to be the attainment of positive utility and the avoidance of negative utility. This simplistic hedonism of the future can easily be translated in terms of a theory of choice. Of the various alternatives offered, man chooses the one that gives him a maximum of utility. The idea of choice being determined by utility is a fundamental conception of the theory of decision-making.

Economists and statisticians distinguish between decision-making *under risk* and decision-making *under uncertainty*. The term decision-making under risk is used if one knows the probabilities of the possible events. If the possibilities are not known the term used is decision-making under uncertainty.

The experiments discussed below deal with the theme of decision-making under risk. As is customary in this type of experiment, the *S*s. must choose between two alternative bets, each in the form: probability p to win Dfl. A and probability $1\text{-}p$ to loose Dfl. B.

The first model of decision-making under risk to be known was, perhaps, the theory that one maximizes the expected value (EV) of the bets: i.e., choses the bet with the highest expected value. The expected value (EV) is defined as:

$$EV = \sum p_i\, v_i$$

where p_i denotes the probability and v_i the value of the i^{th} component of the bet.

It appears, however, that man does not behave in accordance with this "rational" theory. As early as 1738, Bernoulli pointed out that man does not choose according to the maximization of the objectively expected value, but to that of the subjectively expected value or utility. According to Bernoulli, the utility of money is a non-linear function of the money value. The theory of the maximization of the utility was once more defended and formalized in 1944 by von Neumann and Morgenstern (20) and since then has held an important place in decision-making theory. It very soon became apparent that this theory, too, could not explain the observed facts. An attempt was made to retain the model, but to introduce subjective instead of objective probabilities. In 1948 Preston and Baratta (21) tried to measure the subjective probabilities on the hypothesis that the utility of money is a linear function of the objective value. In 1955 Edwards (13) proposed the *SEU* model, which implies that the choice is determined by the maximization of the subjectively expected utility. The subjectively expected utility, *SEU*, is defined as:

$$SEU = \sum P_i u_i$$

where P_i denotes the subjective probability and u_i the utility of the i^{th} component.

The trouble with this model is that one is left with, virtually, an equation with two unknowns, P_i and u_i. This being so, a separate measurement of the utility and the subjective probability is not possible unless one succeeds in keeping one of the two variables constant. Various attempts have been made to measure the utility of money (7, 13, 18) and to determine the size of the subjective probabilities (13, 21).

The state of affairs at present is such that the *SEU* model gives little satisfaction, and one wonders whether the model should not be revised, or even whether it should not be dropped altogether (5). It would seem reasonable to suppose that one chooses in such a way that the choice will result in the greatest advantage or the least loss. What exactly is maximized and which factors influence the choice?

There can be various reasons why the predictive value of the *SEU* model is not as good as one would wish. In the first place the model assumes independence of subjective probability and utility. This assumption cannot easily be verified. It is certain that the subjective probability is dependent on positive or negative utility (15, 17). The present writer (17) has established that the utility is dependent on the probability.

In publications on this subject, two other factors, namely probability preference and variance preference are mentioned which influence the predictive value of the *SEU* model in unfavourable way and which should they be relevant, are disastrous for the model.

Probability preference denotes preference for playing under certain probabilities. Edwards (8) noted that in bets with an $EV = 0$ or with a positive *EV* there was a preference for a gain probability of 4/8 and an avoidance of a gain probability of 6/8. Later he confirmed this result in various experiments (10, 11). Similarly Atkinson (2) and Littig (16) established a preference for certain probabilities. Since Edwards took no account of the difference in variance of the bets, the specific probability preference established by him could possibly be interpreted as variance preference. This point was put forward by Coombs and Pruitt (5). These two writers themselves carried out an investigation on probability preference. Their interpretation of the term, however differs from that of Edwards. They take probability preference to mean preference for skewness, that is preference for playing with small probabilities of large gain or preference for playing with a large probability of small gain. Probability preference as preference for skewness could mean that the risk, too, has utility, and in this case the *measured* utility of money for a given person would certainly be dependent on the probabilities used.

Coombs and Pruitt take as their starting point the Unfolding Theory of Coombs (4). According to this theory each subjective probability can be looked upon as a point on a continuous probability scale. The scale of preferences for a given *S* is created by folding the common *J*-scale at the ideal point for the *S*. Obviously, with this model, the scale value of the second most preferred probability must border on the scale value of the most preferred probability. Assuming that the sequence of the values on the *J*-scale corresponds with the sequence of the objective values of the probabilities, there is no place in this model for a specific probability preference, such as we found by Edwards. Indeed, it has not yet been proven whether it does exist or whether it is a result of the inaccurate design of Edwards' experiments. This point will be investigated in our own experiments.

The second factor, namely the concept *variance preference*, is older. As early as 1906, Fisher (14) pointed out that decisions made were dependent not only on the expectation, but also on the distribution of the possible results. It was Allais (1) who first secured general acceptance of this concept in 1953, when he criticized the American school and drew attention to the importance of the variance. Edwards (12) established that such a factor as variance preference is present provided the EV is kept constant, but that its influence is of subordinate importance. The conclusion of Myers and Sadler (19) was also that the variance preference played a secondary role. Littig (16), too, established the existence of variance preference, though he did not investigate the degree of its importance.

In their experiment mentioned above, Coombs and Pruitt made a detailed investigation on variance preference. In their attempt to find an alternative possibility to the SEU model, they point out that, instead of assuming a non-linear utility curve for money, one can assume that the utility is linear with the amount of money but that the deviations measured are determined by variance preference. By applying the Unfolding Method in their investigation, they demonstrate that this hypothesis is indeed a possibility, though the investigation is not conclusive enough to repudiate the theory of a non-linear utility curve.

The variance of a bet is defined as follows: If a bet has two possible outcomes, probability p of gain A and probability q of gain B, then the variance V is:

$$V = pq\,(A-B)^2.$$

The skewness of the distribution is defined as

$$S = \frac{1-2p}{\sqrt{pq}}.$$

Our investigation is concerned with the following points:

1. Should probability preference be interpreted, after Edwards, as specific preference for certain probabilities, or, after Coombs and Pruitt, as preference for skewness?
2. Is variance preference really a significant factor, even when the EV of the bets is not constant?
3. Is there any relationship between probability preference and variance preference?

Method

The Ss received booklets in which the bets were arranged in pairs. They had to state which bet of each pair they preferred. The bets used are described more fully in the various experiments.

77 students, divided into four groups, took part in all the experiments. At each session all experiments were carried out in random sequence.

Each S took part 3 times in 3 repetitions with a week's interval between. The experiments were carried out individually or in small groups. No time limit was set and therefore everyone could work at his own pace.

The Ss were informed about the general set-up and were asked to choose, in each case, the alternative they considered to be the most favourable. The S was warned to be careful about making his choice since it was possible that each choice would later be played and the size of his gain was dependent not only on his luck, but also on whether he had always managed to choose the better alternative. After three sessions the gain or loss for each S was determined, based on the alternatives chosen by the S of a random selection of 50 items. For each group of 19 (20) Ss, four prizes were awarded to those with the largest nett gain (or the smallest nett loss). The prizes were Dfl. 10.—, Dfl. 7.50 and two pocket books at choice.

Results

Experiment I

Probability Preference. An investigation on probability preference was made in this experiment. The preference for playing with a given probability was determined for the bets with gain probabilities of 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, and 0.9 with an expected value of 0 and a constant variance. The probability preference was determined at two levels of variance, namely 0.25 and 100. Within each level of variance the bets were exhaustively paired, producing a total of 72 pairs. Together with the 30 pairs of exp. II these were presented in random sequence. Table 1 gives the bets used in this experiment. The variance of 100 is approached as closely as possible by an $EV = 0$.

Consistency. For each of the two conditions, low and high variance, the sequence of preference of the 9 probabilities was determined for each S. The first point of investigation was whether the preference of each S met the criterion of *weak* stochastic transitivity. The concept weak stochastic transitivity was defined by Davidson and Marschak (6) as follows:

$$\begin{array}{rl} \text{if} & p(a, b) \geqslant 0.5 \\ \text{and} & p(b, c) \geqslant 0.5 \\ \text{then} & p(a, c) \geqslant 0.5 \end{array}$$

If this condition is met, a sequence of preference for the stimuli can

TABLE 1

Gambles used for determination of probability preferences at low (0.25) and high (100) variances.

	EV	Variance
Prob. 0.1 to win fl. 1.50 and prob. 0.9 to lose fl. 0.17	0.00	0.25
„ 0.2 „ „ fl. 1.00 „ „ 0.8 „ „ fl. 0.25	0.00	0.25
„ 0.3 „ „ fl. 0.76 „ „ 0.7 „ „ fl. 0.33	0.00	0.25
„ 0.4 „ „ fl. 0.61 „ „ 0.6 „ „ fl. 0.41	0.00	0.25
„ 0.5 „ „ fl. 0.50 „ „ 0.5 „ „ fl. 0.50	0.00	0.25
„ 0.6 „ „ fl. 0.41 „ „ 0.4 „ „ fl. 0.61	0.00	0.25
„ 0.7 „ „ fl. 0.33 „ „ 0.3 „ „ fl. 0.76	0.00	0.25
„ 0.8 „ „ fl. 0.25 „ „ 0.2 „ „ fl. 1.00	0.00	0.25
„ 0.9 „ „ fl. 0.17 „ „ 0.1 „ „ fl. 1.50	0.00	0.25
Prob. 0.1 to win fl. 30.00 and prob. 0.9 to lose fl. 3.33	0.00	99.98
„ 0.2 „ „ fl. 20.00 „ „ 0.8 „ „ fl. 5.00	0.00	100.00
„ 0.3 „ „ fl. 15.40 „ „ 0.7 „ „ fl. 6.60	0.00	101.64
„ 0.4 „ „ fl. 12.30 „ „ 0.6 „ „ fl. 8.20	0.00	100.86
„ 0.5 „ „ fl. 10.00 „ „ 0.5 „ „ fl. 10.00	0.00	100.00
„ 0.6 „ „ fl. 8.20 „ „ 0.4 „ „ fl. 12.30	0.00	100.86
„ 0.7 „ „ fl. 6.60 „ „ 0.3 „ „ fl. 15.40	0.00	101.64
„ 0.8 „ „ fl. 5.00 „ „ 0.2 „ „ fl. 20.00	0.00	100.00
„ 0.9 „ „ fl. 3.33 „ „ 0.1 „ „ fl. 30.00	0.00	99.98

be determined for a given *S* on the grounds of his preference in the paired comparisons of the stimuli.

The average uncertainty *H* observed over the number of pairs of alternatives was determined for each *S*. The statistic $2n\,(H_{max} - H)/ld\ e$ has a χ^2-distribution, where n is the number of pairs of stimuli (36), of which the average is calculated. The level of significance chosen was the 1 % level. Out of a total of 77 *S*s the choices of 11 *S*s. were not consistent in the case of low variance and the choices of 8 *S*s in the case of high variance, according to this criterion.

The uncertainty *H* is an index of the degree of consistency over all pairs of comparisons of stimuli and can thus be taken as an index for weak stochastic transitivity.

Moreover, the coefficient of agreement *U* of Kendall which is an index of the consistency of a *S* over a period of time was determined for each person.

The results of the *S*s who, according to both of these criteria, showed no significant degree of consistency and these were all the *S*s for whom

H was not significant will, in part, be mentioned separately in the further analysis. Table 2 gives the average H and U for the total group, the inconsistent group, the group "purificated" for inconsistency and the group with a common J-scale of Coombs.

TABLE 2

Mean uncertainty H and coefficient of agreement U

	low variance			high variance		
	N	H	U	N	H	U
A. total group	77	0.3886	0.43	77	0.3794	0.45
B. inconsistent-group	11	0.6605	0.04	8	0.6782	0.01
C. group A–B	66	0.3567	0.49	69	0.3312	0.50
D. group with scale of Coombs	15	0.2142	0.67	24	0.2394	0.65

$r = +0.76$

The correlation between the uncertainties in the case of low and high variance amounts to $r = +.76$, a value which is highly significant. This indicates that the degree of consistency in probability preference is an rather constant characteristic in each individual.

Preference for skewness—Unfolding analysis of the preferences. According to Coombs and Pruitt (5), probability preference must not be looked upon as a specific probability preference, but as preference for skewness, in which case the ordering of preferences for the probabilities can be considered to be I-scales, obtained by folding the common J-scale at the ideal point of the S—i.e. at the value on the scale which the S considers the most ideal. This being so, we shall begin by testing this statement on the basis of the results of our own Ss. Where there are 9 stimuli, there are 37 possible I-scales based on one common *quantitative* J-scale.

Table 3 summarizes the results of those Ss who have an ordering of preferences of the probabilities which is possible with a common J-scale. In the case of low variance, only 15 of the 77 Ss have an I-scale based on a common quantitative J-scale; in the case of high variance there are only 23 Ss whose sequence of preference leads to the assumption of a common quantitative J-scale, whilst there is one S for whom other metric relations exist.

The number of Ss who can be said to have a preference for skewness is thus relatively small, much smaller than the number arrived at by

TABLE 3

I-scales for probability preferences at low and high variance

variance	*I*-scales	*n*	*I*-scales	*n*
low 0.25	123456789	5		
	213456789	2		
	564738291	1		
	675894321	1		
	786954321	1		
	789654321	1		
	879654321	1		
	897654321	0		
	987654321	3		
	total	15		
high 100.00	123456789	9		
	213456789	0		
	231456789	1		
	435267189	1		
	546372891	1		
	564738291	1		
	567489321	1		
	567849321	1		
			765843291	1
	786594321	1		
	786954321	1		
	789654321	0		
	879654321	1		
	897654321	3		
	987654321	2		
	total	23		1

Coombs and Pruitt. For the probabilities 1/6, 1/3, 1/2, 2/3 and 5/6, these authors noted that 57 of the 95 *S*s in the case of low variance (1.00) and 59 of the 94 *S*s in the case of high variance (25.00) had *I*-scales based on a common *J*-scale. Of the remaining 73 scales, only

12 were intransitive. When the authors left the probability 1/2 out of consideration—a probability for which they established a specific probability preference—82 of the 89 *S*s had a preference ordering based on a common *J*-scale in the case of low variance and 73 of the 88 *S*s in the case of high variance.

If we exclude the probability 0.5 from our experiment, then the number of *I*-scales which fit a *J*-scale is not much larger, namely 19 *S*s for low variance, including 12 of the original 15 *S*s, and 28 *S*s for high variance, including 21 of the original 24 *S*s.

Specific Probability Preference. Edwards (8) noted a preference for $p = 4/8$ and an avoidance of $p = 6/8$ in bets of which the expected value was positive or zero. In some of his later experiments (10, 11) he also noted an avoidance of $p = 3/8$. Since Edwards did not keep the variance of the bets constant, the probability preference established by him could be partially interpreted as variance preference. The results of our own experiment will be used to determine to what degree the probability preference found by Edwards is a genuine phenomenon.

TABLE 4

Relative probability preferences at low and high variance. A. for the total group; B. for the group purificated for inconsistency; C. for the group without *S*s with a scale of Coombs

var.	group	*N*	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	total
0.25	A	77	9.37	9.95	9.31	10.47	14.09	12.05	12.38	12.36	10.02	100.00
	B	66	9.48	9.79	9.12	10.40	14.41	11.94	12.36	12.54	9.96	100.00
	C	51	9.24	9.35	8.57	10.15	14.98	11.87	12.51	13.04	10.29	100.00
100	A	77	10.69	10.51	10.86	10.56	13.62	11.26	11.83	11.33	9.34	100.00
	B	69	10.91	10.52	10.82	10.74	13.74	11.19	11.74	11.33	9.02	100.00
	C	45	11.48	10.21	10.33	10.00	13.93	10.53	11.67	12.00	9.86	100.01

Table 4 gives for both levels of variance the relative frequency with which each probability is preferred to all other probabilities. The maximum value is 22.22, which would be arrived at if all *S*s always preferred a given probability to all others.

In the rows marked A the results of the entire group of 77 *S*s are given. The results of the group without those *S*s whose choices were so inconsistent that they could be considered to be at random are given in the rows marked B. For purposes of comparison the results obtained without the group with a *J*-scale of Coombs, are given in the rows marked C. These have been added, because the specific preferences of the remaining *S*s stand out more clearly if the probability preference of the group with a Coombs scale is interpreted as preference for skewness, i.e. utility for risk.

Figure 1 presents a diagram of the last-mentioned results.

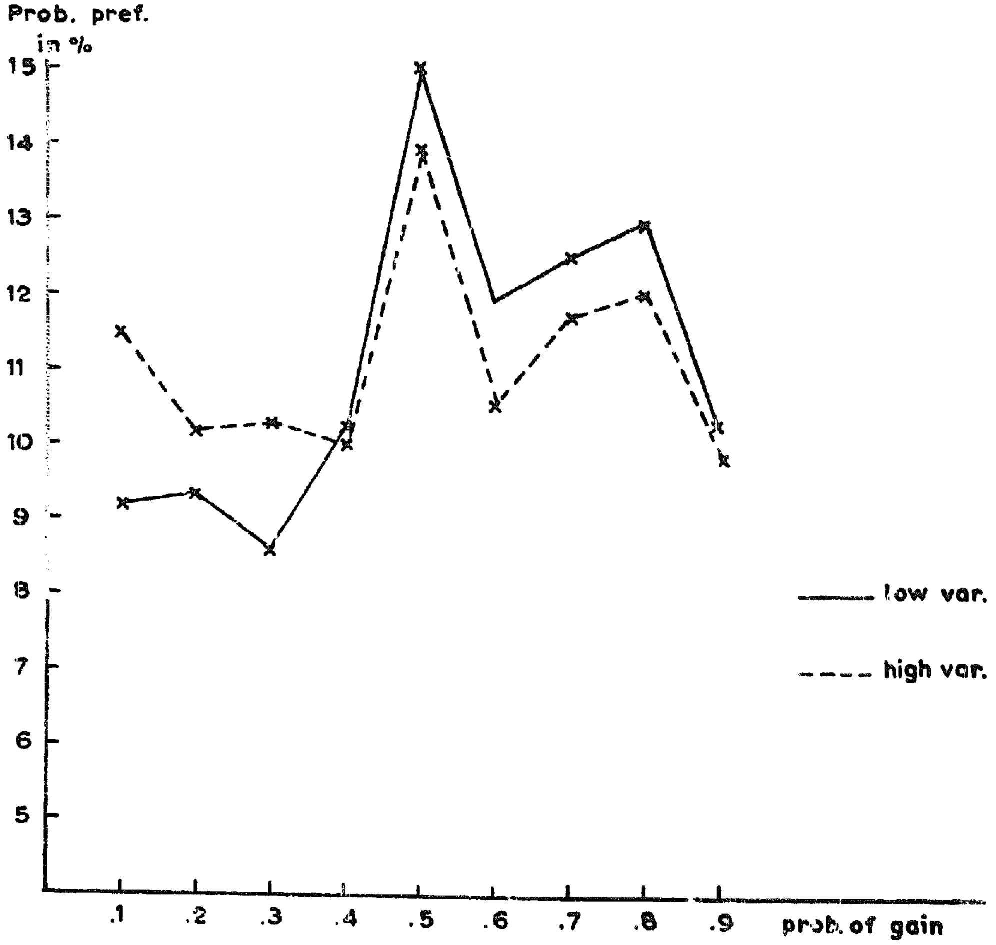

Fig. 1

From table 4 and Fig. 1 it appears, first of all, that there is a specific preference for $p = 0.5$ and for $p = 0.8$ both in the case of low and of high variance. In both conditions of variance, $p = 0.9$ and $p = 0.6$ are avoided and, in the case of low variance, $p = 0.3$ is also avoided.

Another remarkable fact is that there is more preference for the small gain probabilities in the case of high variance than in that of low variance and less preference for the large gain probabilities. Probably the utility of the risk is of greater importance in the case of high variance than in that of the very small variance (0.25) used here.

The pattern of preference occurring in both conditions of variance is rather stable, in spite of the large differences in variance. Nevertheless, in the relative frequencies in which the probabilities are preferred influence is exercised by the level of variance. Coombs and Pruitt established that, in the case of variances of 1.00 and 25.00 and probabilities from 1/6 to 5/6 inclusive, the level of variance had no influence on the probability preference. We find practically no influence of the level of variance on the specific probability preference but some influence on the preference for skewness. Because of the interaction between probabil-

TABLE 5

Preference rankings of the probabilities expressed in number of *S*s. Frequencies lower than 7 have been omitted.

	pr.	ranking of preference									*N*
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	
low variance	0.1	15							11	24	77
	0.2		16					9	20	11	77
	0.3			13			9	22	10	8	77
	0.4			7	19	13	20	7			77
	0.5	20		12	11	22					77
	0.6			11	15	16	19				77
	0.7	11	12	12	10			19			77
	0.8	14	23						17		77
	0.9	7	7	13	8					24	77
high variance	0.1	20						8		26	75
	0.2		18		7			12	19	7	75
	0.3		7	16			9	16	12		75
	0.4				19	13	20		7		75
	0.5	18			12	26					75
	0.6			7	16	14	18				75
	0.7		11	18				21			75
	0.8	17	14						21		75
	0.9	8	7	10	8					27	75

ity preference and level of variance, it is difficult to check the difference between the two conditions with distribution-free tests. Assuming independence, we find a $\chi^2 = 28.085$ for the entire group of 77 *S*s, which with 8 degrees of freedom is significant at the 0.001 level. If we combine the lower 4 and the higher 4 probabilities, and we consider $p = 0.5$ as a seperate class, we arrive at a $\chi^2 = 21.706$ with 2 degrees of freedom. The conclusion would therefore appear justified that the preference for skewness is dependent on the variance. Based on the preference sequences of the *S*s, table 5 presents the number of *S*s who gave each probability a certain ranking as regards preference. For the sake of lucidity, frequencies smaller than 7 have been omitted. In the case of high variance, the results of 2 *S*s for whom even a partial ordering was not possible have been omitted.

The remarkable feature of this table is that most of the spaces filled are those lying along the diagonals. Two tendencies can thus be indicated for this group: a preference ordering from small to large and a preference ordering from large to small probabilities.

In addition, the same specific probability preferences are also demonstrated in this way: preference for the probabilities 0.5 and 0.8 and, to a slightly lesser degree, for 0.7. The least preferred of the large probabilities is $p = 0.9$. Here the avoidance of the probability 0.6 is less pronounced. Furthermore we find a tendency to avoid $p = 0.3$ in the case of low variance and of $p = 0.4$ in the case of high variance. Insofar as it is not accidental, this shift could be the result of the tendency to prefer small probabilities in the case of high variance rather than in that of low variance.

Experiment II

Variance Preference. In this experiment it was investigated whether a preference for variance existed in the case of an $EV = 0$ and a constant gain probability. The variances were 0.25, 1.00, 6.25, 25.00 and 100.00. The variance preference was determined by the gain probabilities 0.2, 0.5 and 0.8. The various bets are given in table 6. These were exhaustively paired within each level of probability, and thus there were 30 pairs of bets. These were presented together with the 72 pairs of bets from the first experiment in random sequence, with this restriction that equal amounts did not occur in two consecutive pairs. A scale of preference based on weak stochastic transitivity, was determined for each *S*, and thereafter the unfolding analysis of Coombs was applied. If there is a

TABLE 6

Gambles used for determination of variance preferences.

	EV	Variance
Prob. 0.2 to win fl. 1.00 and prob. 0.8 to lose fl. 0.25	0	0.25
„ 0.2 „ „ fl. 2.00 „ „ 0.8 „ „ fl. 0.50	0	1.00
„ 0.2 „ „ fl. 5.00 „ „ 0.8 „ „ fl. 1.25	0	6.25
„ 0.2 „ „ fl. 10.00 „ „ 0.8 „ „ fl. 2.50	0	25.00
„ 0.2 „ „ fl. 20.00 „ „ 0.8 „ „ fl. 5.00	0	100.00
Prob. 0.5 to win fl. 0.50 and prob. 0.5 to lose fl. 0.50	0	0.25
„ 0.5 „ „ fl. 1.00 „ „ 0.5 „ „ fl. 1.00	0	1.00
„ 0.5 „ „ fl. 2.50 „ „ 0.5 „ „ fl. 2.50	0	6.25
„ 0.5 „ „ fl. 5.00 „ „ 0.5 „ „ fl. 5.00	0	25.00
„ 0.5 „ „ fl. 10.00 „ „ 0.5 „ „ fl. 10.00	0	100.00
Prob. 0.8 to win fl. 0.25 and prob. 0.2 to lose fl. 1.00	0	0.25
„ 0.8 „ „ fl. 0.50 „ „ 0.2 „ „ fl. 2.00	0	1.00
„ 0.8 „ „ fl. 1.25 „ „ 0.2 „ „ fl. 5.00	0	6.25
„ 0.8 „ „ fl. 2.50 „ „ 0.2 „ „ fl. 10.00	0	25.00
„ 0.8 „ „ fl. 5.00 „ „ 0.2 „ „ fl. 20.00	0	100.00

common quantitative *J*-scale of variances, there are 11 possible *I*-scales. The best fitting quantitative *J*-scale was constructed, i.e. a *J*-scale in which as large a number of *S*s as possible could be included. Table 7 gives the results for each of the three gain probabilities.

The variances in this table are indicated by the letters A up to and including E, from low to high variance.

The first column of table 7 gives the number of the *I*-scale, numbered from low to high variance, and therefore indicates the number of the segment on the variance scale. The corresponding *I*-scales are given in the second column and the number of *S*s along with the relevant *I*-scale in the third column. The fourth column lists the weakly ordered *I*-scales and the fifth column the number of *S*s with these orderings. In the sixth column are given the *I*-scales which fall under the same qualitative *J*-scale but for which other metric relations are required. Their number is indicated in the seventh column.

In all, therefore, if $p = 0.2$ there are 59 *S*s; if $p = 0.5$ 62 *S*s and if $p = 0.8$ 60 *S*s for whom a common quantitative *J*-scale can be constructed. The majority of the *S*s occupy a position at one of the extremities of the variance scale. In the case of $p = 0.2$ there is greater preference

TABLE 7

I-scales for variance preferences at $p = 0.2$, $p = 0.5$, and $p = 0.8$.

pr.	I-scale number	ordered I-scales		weakly ordered I-scales		ordered I-scales with a different metric	
		scales	n	scales	n	scales	n
0.2	1	ABCDE	24	AB(CD)E	1		
	2	BACDE	4				
	3	BCADE	2				
	4	CBADE	1	C(BA)DE	1	BCDAE	1
	5	CBDAE	2			BCDEA	1
	..	....					
	11	EDCBA	23	E(DC)BA	1		
	total		56		3		2
0.5	1	ABCDE	11	AB(CDE)	1		
	2	BACDE	1				
	3	BCADE	1				
	4	CBADE	2				
	5	CBDAE	0				
	6	CDBAE	1				
	7	CDBEA	1				
	8	DCBEA	1	D(CBE)A	1		
	9	DCEBA	1				
	10	DECBA	3				
	11	EDCBA	36	E(DCB)A	1		
	total		58		3		
0.8	1	ABCDE	11				
	2	BACDE	4	BA(CDE)	1		
	3	BCADE	1				
	4	CBADE	1				
	5	CBDAE	1				
	6	CDBAE	3				
	7	CDBEA	1			DCBAE	1
	8	CDEBA	1				
	9	DCEBA	1	E(DC)BA	1		
	10	DECBA	3				
	11	EDCBA	30	E(DCB)A	1		
	total		57		3		1

for low variance than in the case of $p = 0.5$ and $p = 0.8$. In the case of the last two probability conditions, the preference for large variance preponderates. This result is in accordance with the results of Coombs and Pruitt at the probability levels 1/3, 1/2 and 2/3.

TABLE 8
Mean uncertainty H and coefficient of agreement U.

Prob.	group	N	H	U
0.2–0.8	total	77	.3947	.43
	scale of Coombs	61	.3231	.53
	total group without Ss with scale of Coombs	16	.6654	.02
0.5–0.5	group	77	.3038	.55
	scale of Coombs	61	.2285	.65
	total group without Ss with scale of Coombs	16	.5911	.14
0.8–0.2	total	77	.3579	.48
	scale of Coombs	61	.3157	.56
	total group without Ss with scale of Coombs	16	.5736	.17

In table 8 a survey is given of the consistency of the Ss by means of the average uncertainty H and the coefficient of agreement U of Kendall. The correlations between the H's at different levels of probability are given in table 9. The correlations are low, and only the correlation between the uncertainties where $p = 0.5$ and $p = 0.8$ is significant at the 0.01 level.

TABLE 9
Intercorrelations of H at different probability treatments.

	0.2–0.8	0.5–0.5	0.8–0.2
0.5–0.5	.17	—	—
0.8–0.2	.19	.43	—

In all, only 5 of the 77 Ss have intransitive preference scales. As for the remaining Ss, the failure to comply with a preference ordering in accordance with the J-scale is the result of inconsistency.

The results of Coombs and Pruitt, who established that there was a variance preference in the case of $EV = 0$ and constant gain probability, are thus confirmed. It is also confirmed that variance preference is dependent on the gain probability; if the gain probability is 0.5 or larger there is more preference for the large variances than if the gain probabilities are small, when, relatively, there is more preference for the low variance.

Relationship between Probability Preference and Variance Preference. Preference for playing with high variance is considered to indicate a higher utility for risk. A form of utility for risk can also be seen in the preference for skewness. The risk that one prefers in the case of positive or negative skewness, however, is psychologically of a different nature. Atkinson (2) distinguished two types of subjects: those for whom the motivation to achieve success is exceeding the motivation to avoid failure, and those for whom the opposite prevails. He established that the first category prefers intermediate probabilities of success, the second category extreme (low or high) probabilities of success. This may be true. But one can hardly assume that the psychological structure of subjects with a preference for a small probability of large gain and a large probability of a small loss is the same as that of subjects with a preference for a large probability of a small gain and a small probability of a large loss. The first group are the gamblers who are prepared to pay a small amount for a gamble on a large gain; the second group prefers to be almost certain of a small gain as against a small risk of a larger loss. These two forms of risk are not equivalent, and it is therefore not likely that subjects who prefer small gain probabilities and subjects who prefer large gain probabilities will behave identically as regards their preference for high and low variance.

One might expect that these *S*s in order to obtain a small probability of larger gain (the gamblers) by accepting the risk of a small loss would prefer high variance within the limits of what is for them an acceptable loss if there is a small probability of gain. When the probability of gain is large, it is more difficult to forecast their behaviour.

If their love of gambling is motivated by utility for risk, then one would expect in this case, too, a preference for larger risk, i.e. higher variance. If what appears to be a love of gambling is only the result of overestimating the small probabilities, then this would be accompanied by preference for lower variances.

Regarding those who prefer the almost certainty of a small gain combined with the small risk of a large loss, one might expect that they would minimize the size of an almost certain loss and would prefer lower variance if the probability of gain is small. If the probability of gain is large, they would presumable maximize the almost certainty of the small gain sum and would show preference for high variance.

*S*s with preference for small probabilities will be taken to be those who, under both the variance conditions, had the probabilities 0.1, 0.2 and 0.3 in any sequence whatsoever in the first three places of preference; *S*s with a preference for large probabilities are those *S*s who had the probabilities 0.7, 0.8 and 0.9 in one sequence or another in the first three places of preference. *S*s with a preference for low variance are those *S*s who had the two lowest variances (0.25 and 1.00) in the first two places of preference, *S*s with a preference for high variance had the two highest variances (25 and 100) in the first two places of preference.

Table 10 gives those *S*s for whom there was a preference both for small or large probabilities and for high or low variance.

TABLE 10

Relationship between probability preferences and variance preferences.

probability preferences	variance preferences			
	$p = 0.2$		$p = 0.8$	
	low	high	low	high
low	5	17	11	10
high	22	4	4	23

From table 10 it appears that in the case of a gain probability of 0.2, 17 of the 22 *S*s with a preference for small gain probabilities prefer high variances; 22 of the 26 *S*s with a preference for large probabilities prefer low variances. Here we find an important positive correlation between the utility for gambling and the utility for risk. This correlation is significant at the 0.001 level ($\chi^2 = 16.117$ with continuity correction).

When the gain probability is 0.8 we find an equal distribution of the preferences for low and high variance, for *S*s who prefer small probabilities. The *S*s who prefer large gain probabilities show a clear preference for high variance, namely 23 of the 27 *S*s Here the correlation between utility for gambling and utility for risk is negative and significant at the

0.02 level ($\chi^2 = 6.109$ with continuity correction). These results therefore are in accordance with our expectations.

Experiment III

Variance as Variable in the case of Positive and Negative EV. From exp. II it appears that when the $EV = 0$ the variance exercises an influence as a variable. Nothing about the relative importance of this variable can be deduced from the mere fact that the variance is a variable which influences the behaviour of the *S*s when all other conditions are constant. It is possible, as Edwards (12), for instance, assumes, that the

TABLE 11

Gambles used for determination of the strategy in decision making with probability 0.2 to win and probability 0.8 to lose.

				EV
I *a.* 1.20–0.20	II 1.60–0.30	III 2.40–0.50	IV 2.80–0.60	+ 0.08
b. 2.00–0.50	2.00–0.50	2.00–0.50	2.00–0.50	0.00
c. 2.08–0.42	2.08–0.42	2.08–0.42	2.08–0.42	+ 0.08
d. 1.12–0.28	1.52–0.38	2.32–0.58	2.72–0.68	0.00
V *a.* 1.20–0.25	VI 1.60–0.35	VII 2.40–0.55	VIII 2.80–0.65	+ 0.04
b. 2.00–0.50	2.00–0.50	2.00–0.50	2.00–0.50	0.00
c. 2.04–0.46	2.04–0.46	2.04–0.46	2.04–0.46	+ 0.04
d. 1.16–0.29	1.56–0.39	2.36–0.59	2.36–0.69	0.00
IX *a.* 1.20–0.35	X 1.60–0.45	XI 2.40–0.65	XII 2.80–0.75	− 0.04
b. 2.00–0.50	2.00–0.50	2.00–0.50	2.00–0.50	0.00
c. 1.96–0.54	1.96–0.54	1.96–0.54	1.96–0.54	− 0.04
d. 1.24–0.31	1.64–0.41	2.44–0.61	2.84–0.71	0.00
XIII *a.* 1.20–0.40	XIV 1.60–0.50	XV 2.40–0.70	XVI 2.80–0.80	− 0.08
b. 2.00–0.50	2.00–0.50	2.00–0.50	2.00–0.50	0.00
c. 1.92–0.58	1.92–0.58	1.92–0.58	1.92–0.58	− 0.08
d. 1.28–0.32	1.68–0.42	2.48–0.62	2.88–0.62	0.00

influence of the variance is negligible if there are other variables. In this experiment we shall investigate the extent to which a *S* continues to prefer a given level of variance even when this choice proves unfavourable because of the *EV* of the bet. In table 11 the bets used in this experiment when the gain probability is 0.2 are given. Table 12 shows the bets used when the gain probability is 0.8.

Table 13 gives the variances of the bets.

TABLE 12

Gambles used for determination of the strategy in decision making with probability 0.8 to win and probability 0.2 to lose.

								EV
I	a. 0.20–1.20	II	0.30–1.60	III	0.50–2.40	IV	0.60–2.80	−0.08
	b. 0.50–2.00		0.50–2.00		0.50–2.00		0.50–2.00	0.00
	c. 0.42–2.08		0.42–2.08		0.42–2.08		0.42–2.08	−0.08
	d. 0.28–1.12		0.38–1.52		0.58–2.32		0.68–2.72	0.00
V	a. 0.25–1.20	VI	0.35–1.60	VII	0.55–2.40	VIII	0.65–2.80	−0.04
	b. 0.50–2.00		0.50–2.00		0.50–2.00		0.50–2.00	0.00
	c. 0.46–2.04		0.46–[illegible]		0.46–2.04		0.46–2.04	−0.04
	d. 0.29–1.16		0.39–1.56		0.59–2.36		0.69–2.76	0.00
IX	a. 0.35–1.20	X	0.45–1.60	XI	0.65–2.40	XII	0.75–2.80	+0.04
	b. 0.50–2.00		0.50–2.00		0.50–2.00		0.50–2.00	0.00
	c. 0.54–1.96		0.54–1.96		0.54–1.96		0.54–1.96	+0.04
	d. 0.31–1.24		0.42–1.64		0.61–2.44		0.71–2.84	0.00
XIII	a. 0.40–1.20	XIV	0.50–1.60	XV	0.70–2.40	XVI	0.80–2.80	+0.08
	b. 0.50–2.00		0.50–2.00		0.50–2.00		0.50–2.00	0.00
	c. 0.58–1.92		0.58–1.92		0.58–1.92		0.58–1.92	+0.08
	d. 0.32–1.28		0.42–1.68		0.62–2.48		0.72–2.88	0.00

TABLE 13

Variances of the bets used as stimuli in the tables 11 and 12.

Variances of the bets (*b*) and (*c*) are 1.0000 for all of the 16 blocks.

var. of (*a*) and (*d*)	block	var.	block	var.	block	var.	block	var.
	I	0.3136	II	0.5776	III	1.3456	IV	1.8496
	V	0.3364	VI	0.6084	VII	1.3924	VIII	1.9321
	IX	0.3844	X	0.6724	XI	1.4884	XII	2.0164
	XIII	0.4096	XIV	0.7056	XV	1.5376	XVI	2.0736

Under each of the two conditions $p = 0.2$ and $p = 0.8$ there are 16 blocks, each with 4 bets. The 4 bets within each block were combined in pairs. The expected values and the variances of the four bets within each block are always equal, two by two. The size of the expected value is given in the last column of table 11 and 12.

It was possible to determine the strategy which motivated the choice of the *S* from the ordering of the preferences: whether the expected value and the variance exercised predominant or secondary influence on his choice.

For example, for block I the following strategies appeared from the ordering of preference in the case of a gain probability of 0.2 (in descending order of preference):

acbd – the expected value determines the preference
cadb – the expected value determines the preference
acdb – the *EV* in the first place, the lowest variance in the second place determine the preference
cabd – the *EV* in the first place, the highest variance in the second place determine the preference
adcb – the lowest variance in the first place, the *EV* in the second place determine the preference
cbad – the highest variance in the first place, the *EV* in the second place determine the preference.

Of the 4! possible orderings of preference only these 6 occurred. The following partial orderings occurred and were interpreted as follows:

(*a*, *c*) (*b*, *d*) – The *EV* determines the preference
(*a*, *d*) (*b*, *c*) – The lowest variance determines the preference
(*b*, *c*) (*a*, *d*) – The highest variance determines the preference

All other partial orderings were scored as indifferent.

In table 14 mention is made of the relative frequency of the strategy

TABLE 14

Relative frequencies of the strategies applied with gain probabilities of 0.2 and 0.8.*

p \ strategy	v	$v\sigma$	$v\Sigma$	σv	Σv	σ	Σ	i
0.2	.1848	.1609	.1522	.2196	.1986	.0136	.0106	.0598
0.8	.1853	.1095	.2078	.1821	.2296	.0095	.0117	.0644

* Explanation:

v: strategy exclusively determined by the *EV*.
$v\sigma$: strategy in the first place determined by the *EV*; in the second place by preference for the lower variances.
$v\Sigma$: strategy in the first place determined by the *EV*; in the second place by preference for the higher variances.
σv: the lower variances have the most important influence on the strategy; the *EV* ranks second.
Σv: the higher variances have the most important influence on the strategy; the *EV* ranks second.
σ, Σ: strategy exclusively determined by variance preferences.
i: no strategy demonstrable.

applied by the *Ss*. In about 50 % the expected value influences the choice of the alternatives in the first place or exclusively, in about 44 % the variance is more important than the expected value and in about 6 % no consistent strategy can be discerned.

As independent variables in this experiment are varied the probability of gain (0.2 and 0.8); the difference in expected value between the bets (4 and 8 cents); positive and negative expected value and the variance. In order to determine the influence of the variance, the results of the blocks in the columns of table 13 were combined, hence producing 4 levels of variance.

These results were subjected to a multivariable χ^2-analysis according to Suthcliffe (22), and the results of this analysis are summarized in table 15. The categories in which the preference for variance was of exclusive influence were, because of their small frequencies, combined with the categories in which the variance preference was the prime factor.

TABLE 15

Multivariable χ^2-analysis.

source	d*f*	χ^2	*p*
S(trategy)	0	—	
P(robability)	0	—	
EV (expected value)	0	—	
PN (pos.-neg. *EV*)	0	—	
Var(iance)	0	—	
$S \times P$	5	91.3523	0.001
$S \times EV$	5	99.8424	0.001
$S \times PN$	5	24.9459	0.001
$S \times Var$	15	144.1124	0.001
$S \times P \times EV$	5	60.0050	0.001
$S \times P \times PN$	5	4.2604	—
$S \times P \times Var$	15	42.3231	0.001
$S \times EV \times PN$	5	0.8618	—
$S \times EV \times Var$	15	64.4649	0.001
$S \times PN \times Var$	15	52.9113	0.001
$S \times P \times EV \times PN$	5	0.9562	—
$S \times P \times EV \times Var$	15	33.0746	0.005
$S \times P \times PN \times Var$	15	76.5484	0.001
$S \times EV \times PN \times Var$	15	51.2568	0.001
$S \times P \times EV \times PN \times Var$ . . .	15	62.1090	0.001
total	155	809.0245	

This table shows that the strategy is dependent on the probability of gain. When $p = 0.2$ the preference for low variance is larger and the preference for high variance smaller than when $p = 0.8$. This difference is found both where the variance is the most important factor and where it ranks second to the expected value. This agrees with exp. II, where there was also more preference for high variance when $p = 0.8$ than when $p = 0.2$. The difference in probability of gain does not influence the strategy, which is exclusively determined by the expected value, about 18.5 % in both cases.

The strategy is dependent on the size of the *EV*. When the difference in *EV* between the bets amounts to 8 cents, the relative frequency of the strategy that is exclusively or primarily determined by the *EV* is larger than when the difference in *EV* amounts to 4 cents. Moreover, the number of inconsistent answers is larger in the latter case.

When a choice must be made between alternatives with a positive *EV* and an $EV = 0$ on the one hand and between a negative *EV* and an $EV = 0$ on the other, then, in the first case, the frequency of the strategy determined by the *EV* as the most important factor and lowest variance as second factor is larger, and the frequency of the strategy determined by the *EV* as first factor and highest variance as second factor smaller, than in the second case.

The level of variance also has great influence on the strategy. The differences in strategy between the lowest and the highest level of variances are slight, as are the differences between the second and third levels. In the case of the second and third levels the strategy is determined much more by the *EV* than in the case of the first (lowest) and fourth (highest) level. At the first and fourth level of variance, the variance —both as preference for the lowest and as preference for the highest variance—is much more often the dominating factor than at the second and third level.

Since the first and fourth levels of variance accord in the respect that, with both, the difference between the variances of alternatives from which a choice must be made is larger than at the second and third level, it would appear that the *difference* between the variances of the pairs of alternatives is of greater importance than the high or low variance value in itself. One would have to investigate whether this also applies when the variances are greater than those used here. If so, then the preference for variance would be based more on the difference in variances of the alternatives than on preference for a given variance value.

Furthermore, all interactions of a higher order are significant, with exception of $S \times P \times PN$, $S \times EV \times PN$ and $S \times P \times EV \times PN$.

The influence of the variable, positive or negative EV, is slight as compared with the influence of the other variables, namely probability, expected value and variance. This, too, could be an indication that the differences between the variances of the bets play an important role in the decisions of the subjects.

Consistency of the Variance Preference in Exp. II and III. Table 16 gives the numbers of *S*s. who prefer low and high variances in both the experiments. The consistency for the 0.2 probability of gain is good; only 3 of the 65 *S*s. show inconsistency in their preference in both experiments. For $p = 0.8$ the consistency is not quite so good, 9 of the 71 *S*s are inconsistent in their preference.

TABLE 16

Consistency in variance preferences in Exp. II and Exp. III.

variance preferences in exp. III		variance preferences in exp. II		
		low	medium	high
$p = 0.2$	low	28	4	1
	high	2	4	26
$p = 0.8$	low	16	5	7
	high	2	5	36

This consistency in preference for either high or low variance occurs in spite of the fact that the "high" variance category in exp. III is of the same order of magnitude as the "low" category in exp. II.

Hence variance preference is apparently a relative conception and means preference for either the lower or the higher variance that is used in a given experiment.

Relationship between Probability Preference and Variance Preference. In table 17, the number is given of the *S*s who prefer the three smallest, the three intermediate and the three largest probabilities and their preferences for low or high variance in this experiment.

In the case of $p = 0.2$ (see table 10) a preference for small probabilities is accompanied by a preference for high variance and a preference for large probabilities by a preference for low variance.

TABLE 17

Relationship between probability and variance preferences in Exp. III.

variance preferences in exp. III		variance preferences low	medium	high
$p = 0.2$	low	3	8	24
	high	20	6	8
$p = 0.8$	low	15	4	7
	high	11	7	24

As regards a probability of gain of 0.8, we find here, too, an opposite tendency, in which especially preference for large probabilities is accompanied by preference for high variance, whereas, in the case of preference for small probabilities the preference for low and high variance is roughly equally distributed.

DISCUSSION AND CONCLUSION

It is clearly evident from exp. I that a specific probability preference, such as was noted by Edwards in the case of inequal variances, also exists when the variance is kept constant. The specific probability preference noted by Edwards cannot, therefore, be attributed to differences in variance between the bets used by him. The specific probability preference appears to be highly independent of the level of the variances.

In addition there is a probability preference that is preference for skewness. The number of *S*s who conform to a *J*-scale of Coombs is not nearly so large in our experiment as in that of Coombs and Pruitt. This is due, in part, to a larger inconsistency of the *S*s in the larger number of probabilities used by us, but more especially it is due to intransitivity as a result of the specific probability preferences. Presumably the reason why Coombs and Pruitt found no specific probability preference except for the probability 1/2 is that they used a small number of probabilities.

The preference for skewness—conceived more broadly as preference for the smallest, the intermediate and the largest probabilities—could be based on two factors: the utility for risk, which means preference for the sort of risk that implies a certain probability, and over-estimation of the probabilities of preference.

Both factors probably exercise an influence, and a reciprocal influence is not impossible. It would be difficult to differentiate between the two. At any rate it is impossible to determine the subjective probabilities in these experiments on the basis of the frequency estimations of the *S*s or on the basis of their forecast of the events of which the objective probabilities are given. As soon as decisions are made that are based on probabilities and values, the subjective probabilities change.

The variance, too, is a variable that influences the decisions of the *S*. It is true that the variance is confounded with the utility of the monetary value of the outcomes, but, unless one accepts a utility curve with a great many points of inflection, the variance must be looked upon as a separate variable. In exp. III, therefore, the majority of the *S*s recognized that the variance is a variable, namely in more than 75 % of all the strategies, whilst in about 44 % the variance is more important than the expected value of the bet.

Although it has been demonstrated that the variance is a variable that influences the decision of the *S*s and is more important than the expected value in many instances, it does not seem likely that the variance, in its objective definition, is a psychological variable. The variance is alike in the case of the gain probabilities 0.2 and 0.8 if the pay-offs are the same, but the preference for a variance of a given degree is highly dependent on the gain probability and hence on the nature of the risk that is preferred. From a psychological viewpoint, the variance could be a risk variable that is highly dependent on the probability of gain or loss.

The results of exp. II could support the supposition that the variance preference is created by the application of the simple rules: always choose the bet with the largest gain or always choose the bet with the smallest loss. If this line of conduct would be applied we would find that all *S*s. occupied both the extreme intervals of the *J*-scale. We have seen in exp. II (table 7) that by far the greatest number of the *S*s occupy a place at one of the extremities of the scale and that positions between the extreme intervals are rather rare. In how far is variance preference brought about simply by automatically applying one of the two rules? In exp. III the only strategies that comply with these rules are those in which the variance is the most important variable and the *EV* comes second, i.e. in 42 % of all the strategies.

Altogether this strategy occurs to a considerable degree with 32 of the 77 *S*s. Other strategies are also applied by most of these *S*s and therefore there can be no question of an automatic application of the rules: choose the largest gain, or choose the smallest loss.

Of these 32 *S*s there are 2 *S*s who prefer the lowest variance both when the gain probability is 0.2 and when it is 0.8, i.e. their preference for the lowest amount of loss is always independent of the probability. Both these two *S*s. prefer the highest probabilities, in exp. II the lowest variance in the case of $p = 0.2$ and the highest variance in the case of $p = 0.8$. There is, therefore, no question of a consistent application of the rule about loss under all circumstances.

4 *Ss* prefer the highest variance under both conditions of probability, and thus their decision could be based on the highest amount of gain. All prefer the smallest probabilities and, in exp. II, always the highest variances. It is not possible to decide whether this group automatically reacted to the highest amount of gain or whether the group preferred the greatest risk under all conditions.

10 *Ss* prefer the highest variance (largest amount of gain) in the case of $p = 0.2$, and the lowest variance (smallest loss) in the case of $p = 0.8$. The strategy here, therefore, depends on the probability of gain. 9 *S* prefer the smallest probabilities, in exp. II all prefer the highest variance in the case of $p = 0.2$; in the case of $p = 0.8$, 3 *Ss* prefer the lowest, 5 the middle and 2 the highest variance. Deviations thus occur once more when the gain probability is 0.8. It would appear that in this category of those taking risks, the amounts that can be won when the probability is 0.8 must be of a certain size before the risk becomes attractive. In addition the overestimation of the probability 0.2 is possibly a point of consideration.

16 *Ss* prefer the lowest variance (smallest loss) when the probability is 0.2, the highest variance (the largest gain) when it is 0.8. All *Ss* prefer the largest probabilities. In exp. II, 13 *Ss* prefer the lowest, 2 *Ss* the intermediate and 1 *S* prefers the highest variance in the case of $p = 0.2$; in the case of a gain probability of 0.8 there are 15 *Ss* who prefer the highest and 1 *S* who prefers the lowest variance. Presumably the best explanation of the results of this group is an overestimation of the probability 0.8 and an underestimation of the probability 0.2.

These results are admittedly not conclusive, but it would appear unlikely that the decisions made were to a considerable degree induced by the rules: always choose the largest gain, or always choose the smallest loss. In that event one would expect a greater degree of consistency in the application of one of these rules than is the case here. The most obvious criteria that appear to have guided the decisions are the amount of risk that is acceptable for a given *S* and over- and underestimation of the probabilities.

One remarkable result is that in only about 8 % the expected value of the bet was not recognized as a variable. In about 50 % the expected value was the most important variable that determined the *S*'s decisions. In these instances there was no question of an application of the gain or loss rule.

On the basis of these investigations, it does not seem likely that the decisions made under risk can be forecast with any degree of accuracy by means of a formal model that only takes account of mutually independent subjective probabilities and utility of the outcomes (*SEU* model). The nature of the risk preferred by a *S* has an important influence on his decision. The variance is a risk variable which, however, cannot be separated from the probability of gain or loss, which is similarly a risk variable.

If the values of the subjective probabilities are determined and if a utility curve is then constructed on the basis of these values, the measured utility would not be a true determination of the utility of money values, but the resultant of utility of money, utility for risk and of utility for gambling and, in consequence, would be dependent on the size of the gain and loss probabilities that determine the utility curve. Moreover it is apparent that the utility for risk and the utility for gambling also influence the measuring of subjective probabilities in the case of decisions under risk, with the result that these are different when the element of risk is not present.

If a reliable forecast is to be made of the decisions of a *S*, account must be taken of the nature of the risks preferred by that *S*, and an investigation into the psychological structure of the subjects who prefer the various forms of risk would appear to be necessary.

Summary

In three experiments, in which 77 *S*s praticipated, an investigation was made into probability preference, variance preference and the relative importance of expected value and variance preference.

Probability preference does not appear to be an unambiguous conception, but one which occurs in two forms: as specific probability preference (a preference for certain probabilities and an avoidance of other probabilities) and as preference for skewness (preference for small, intermediate or large probabilities).

A specific preference was found for the probabilities 0.5, 0.8 and 0.7 and a relative avoidance of the probabilities 0.9 and 0.6 and, when the variance was low, 0.3. The pattern of the specific probability preference is to a high degree independent of the variance.

The preference for skewness does appear to be dependent on the variance. If the variance is high, there appears to be more preference for the small probabilities and less preference for the large probabilities than in the case of low variance.

The existence of variance preference could be demonstrated when the probabilities were 0.2, 0.5 and 0.8. The ordering of preference of 61 of the 77 *S*s under the 3 conditions of probability conformed to a common *J*-scale of Coombs, with most of the *S*s at one of the extremities of the scale. When the gain probability was 0.2 there was more preference for low variance than when the gain probability was 0.5 or 0.8, in which cases the preference for high variances prevailed. Variance preference is dependent on the probability of gain or loss.

In the case of a gain probability of 0.2, the majority of the *S*s who preferred positive skewness had a preference for high variances, *S*s who preferred negative skewness had a preference for low variances. In the case of a gain probability 0.8, the majority of *S*s who preferred a negative skewness had a preference for high variance, whereas the *S*s who preferred positive skewness were roughly equally divided as regards their preference for low and high variance. This relationship obtained for the variance preference in both exp. II and exp. III.

In the third experiment, bets with inequal and equal variances and inequal and equal expected values were combined, so that from the ordering of preference it could be determined for each S to what extent both the variables influenced the decisions made. In about 18.5 % only the expected value had an influence on the Ss's strategy, in about 31 % the expected value was more important than the variance—though the latter did influence the strategy chosen—, in about 42% the variance was more important than the expected value and in about 2 % the variance but not the expected value determined the strategy.

The strategy of the Ss appeared to be dependent on the size of the probability of gain, on the expected value, on whether the expected value was negative or positive and on the difference in variances between the pairs of bets from which a choice had to be made.

Although the "high" variances in exp. III were of the same order of magnitude as the "low" variances in exp. II, the Ss were to a high degree consistent in their preference for low and high variance. Only 3 of the 71 Ss were inconsistent in the case of $p = 0.2$ and 9 in the case of $p = 0.8$. This indicates that variance preference is a relative conception.

Variance preference appears to be a variable of which account must be taken. Psychologically it can best be interpreted as a risk variable which, nevertheless, always must be considered in connection with the gain or loss probability and with the nature of the risk accompanying a given probability.

A model that takes no account of the utility for risk and of the utility for gambling would appear to have little chance of success. For the time being it would appear necessary to obtain a better insight into the various forms of risk and the personality variables that underly the preference for different forms of risk.

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