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ABSTRACT

Sixty-four 4th graders were subjects in this experiment which examined children's choice behavior under conditions of uncertainty. In the experimental condition, 2 rewards were offered, one of which was concealed by a question mark. In addition the question mark concealed one of 2 possible rewards, presented according to varied probability schedules. To the subjects, it was uncertain what was under the question mark. The control condition contained no such uncertainty, since the question marks were colored and associated with a specific, known reward. Findings indicate that children chose the question mark more frequently in the experimental condition than in the control condition. Other findings are also reported which suggest that the desire to reduce uncertainty is not the only variable operating, but that the value of the reward influences choice as well. The data points to the incentive properties of uncertainty reduction, or information, for children. Implications for learning are touched upon in the discussion. (TL)

EFFECTS OF UNCERTAINTY REDUCTION, REWARD VALUE, AND VARIETY ON CHILDREN'S CHOICE BEHAVIOR

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The present experiment was designed to isolate the incentive properties of uncertainty reduction, or information, from those of material reward value and variety of reward objects in a binary, competitive reward situation. Incentive has been defined by Logan and Wagner (1965) as the "expectation" that reinforcement will follow a response based on previous experience with the response and its consequences. Both material and verbal incentives have been shown to influence the performance of normal and mentally retarded children on a number of different tasks involving choice behavior, selective learning, attention, and verbal learning (see reviews by Witryol, 1971, and Siegel, 1968).

Feldstein and Witryol (1971) obtained evidence for the incentive value of uncertainty reduction in an experiment with fourth grade children. Ss were placed in a binary, competitive reward situation with an object of high relative value (bubble gum) as one choice and a package which concealed a reward of equal value (bubble gum or charm) on half the preference trials and one of lower value (paper clip or bean) on the other half. Since the package contained one of four possible objects, each appearing on 25% of the trials according to a random schedule, viewing the content supplied two bits of objective information.

Uncertainty reduction was operationally defined as getting to see which of the four equally likely alternatives a package contained after each trial, or after specified numbers of trial blocks; it could be obtained only by choosing a package or packages. Results of choice behavior analyses were interpreted as showing that the expectation of uncertainty reduction served as an incentive which increased the response frequency of choosing packages, beyond the choice frequency based on the average value of two high and two low reward objects.

Since amount of uncertainty, or potential information, was defined solely in terms of number of equally likely alternative objects, there is a possibility that packages were chosen in order to obtain a variety of rewards rather than information. In the present experiment an attempt was made to hold variety constant while manipulating the presence and absence of uncertainty in a within-Ss design. Children were given 40 two-choice preference trials on which a prescaled high reward object (bubble gum) was always one alternative; the second alternative consisted of moderate (marble) and low (bean) valued objects, each presented on a fixed proportion of the trials according to a random schedule. Reward values had been prescaled by the method of paired-comparisons in a study by Haaf, Feldstein, and Witryol (1970).

The high value bubble gum reward was always covered by a stimulus display which consisted of a piece of bubble gum mounted on a white card. Marble and bean were concealed by a colored, planometric question mark, also mounted on a white card. Under the experimental (uncertainty) condition S could reduce uncertainty about the concealed object by choosing the question mark rather than bubble gum. Each S also served

in a control or no uncertainty condition in which color of the question mark cued the presence of a marble or a bean. The two conditions were identical except for the presence or absence of uncertainty.

Independent groups of Ss were presented with two different levels of uncertainty under the question mark stimulus display. Half the Ss received a 50%-50% probability schedule whereby a marble was present 50% of the time and a bean was present on the remaining 50% of the trials. Since question mark concealed one of two equally likely alternatives per trial, it contained one bit of uncertainty. The remaining half of the Ss received a 90%-10% probability schedule whereby one object, marble or bean, was present 90% of the time and the other object only 10%. Under this probability schedule choice of question mark was calculated to yield an average of approximately .47 bit of information (Attneave, 1959). In addition, half the 90%-10% Ss were presented with marble on 90% of the trials and bean on 10% (Group 90-10), and the other half received the opposite reward distribution (Group 10-90).

It was predicted that question mark would be chosen more frequently under the experimental (uncertainty) condition than under the control condition (no uncertainty) in the two choice preference task. It was further predicted that Ss receiving one bit of information per question mark choice would make more such choices than Ss receiving only .47 bit. Finally, it was expected that choice of question mark would be more frequent in the group presented with 90% marbles and 10% beans than in Group 10-90, despite the fact that information value was equal at .47 bit in both groups. The final prediction is based on the higher scaled reward value of marble over bean.

Method

Subjects and Apparatus

A total of 64 fourth grade children from two predominantly middle-class public schools in Northeastern Connecticut served as Ss. Mean CA was 9 years, 10 months with a standard deviation of 5 months. They were randomly divided into four independent groups of 16 Ss each, with the restriction of equal sex representation. Characteristics of the groups are described in Table 1. Groups 50-50 (A) and (B) were treated identically and divided only for ease of analysis.

Insert Table 1 about here

A modified version of the Wisconsin General Test Apparatus was employed in the experiment; it is illustrated in Figure 1.

Insert Figure 1 about here

S sat facing a vertical panel which contained a one-way mirror. A retractable sliding tray, containing two circular reward wells covered by stimulus displays, was presented directly in front of S. The paired stimulus displays were a wrapped piece of bubble gum and a 4 x 2 cm. planometric, cardboard question mark, each mounted on a white 10.5 x 10 cm. card covering a gray wooden wedge. The question mark was colored either red or black on any trial.

Design

The basic experimental design was a 2 x 2 x 2 factorial with uncertainty, present or absent, as a within-Ss factor and probability schedule (50%-50% vs. 90%-10%) and reward distribution (90% marbles vs. 90% beans, within the 90%-10% schedules) as between-Ss factors. Group 50-50 (A) was combined with the 90-10 (marble) group and 50-50 (B) with the 10-90 (bean) group for purposes of analysis, but no differences, either statistical or logical, were expected between the 50-50 groups. Sex and order of sessions (experimental or control first) were included in the analysis of variance.

Procedure

Each S was run on two separate occasions, at least six days apart, with the experimental treatment presented at one session and the control treatment at the other. Order of sessions was counterbalanced. Each session consisted of pretraining followed by a 40 trial preference test. At the beginning of his first session only, regardless of the condition, each S was given pretraining on 10 single presentations of the bubble gum stimulus display and reward, with position counterbalanced, in order to familiarize him with the stimulus-reward combination. S was reminded of this association during the second session, but further training was not necessary.

At each session S received a 40-trial single stimulus, question mark, training series designed to familiarize him with (a) the reward objects present under the colored question mark stimuli, (b) the probabilities with which marble and bean would be found under the question mark, and (c) the color of the question mark always paired with marble

and the color always paired with bean, but only in the control session. For example, S might have been told that marble was always under the red question mark and bean always under the black question mark. Under the experimental condition each reward object was paired with each color on half the trials that the object was presented, according to a random schedule. Thus, question mark color cued the presence of marble or bean under the control condition but *not* under the experimental condition.

After pretraining each S was presented with 40 choice trials on which he could choose the high value bubble gum or the object concealed by question mark. S placed each choice in a paper bag which was his to keep at the conclusion of the experiment. Each choice was manually recorded by E.

Results

Question mark choices were subjected to the previously described analysis of variance. The only significant main effect, uncertainty conditions within Ss ($F = 14.16$, $df = 1/48$, $p < .001$), confirmed the major prediction that more question marks would be chosen under the experimental than under the control condition where uncertainty was removed before a choice was made. Mean question mark choices for each of the probability-schedule, reward-distribution groups under experimental and control conditions are presented in Table 2 which shows more mean choices for the experimental conditions within all four independent

Insert Table 2 about here

groups. Multiple comparisons by Tukey's method (Guenther, 1964) revealed that three groups--both 50-50 groups and the 10-90 group--chose significantly more question marks under the experimental condition, each yielding $p < .01$. The difference in mean choices favoring experimental over control treatment within the 90-10 group was only 1.5 choices and was not statistically significant. These mean choice differences within groups, as well as differences between groups, are graphically displayed in Figure 2.

Insert Figure 2 about here

It is obvious from Figure 2 that the 90-10 (marble) group made the largest number of question mark choices despite receiving only .47 bit of information per choice. Thus, the second prediction was not supported. It appears that material reward value, rather than information value, carried the major variance in the experimental between-group comparisons. Perhaps the difference between one and .47 bits is insufficient to overcome the differences in reward value between marble and bean, especially since both these information values are small. The only significant difference among the four vertical points at the left of Figure 2 was between the 90-10 (marble) and 10-90 (bean) groups ($p < .05$ by Tukey test), thus supporting the prediction of a difference based on reward value when information values are equal.

Discussion

The present data, along with those of Feldstein and Witryol (1971), point to the incentive properties of uncertainty reduction, or information, for children. Although various theorists have discussed similar notions (Berlyne, 1967; Dember, 1965; Fowler, 1967; Gibson, 1970; Hunt, 1965; Munsinger and Kessen, 1966), there has been no research employing information as a unifying construct. This omission is puzzling in light of Berlyne's explicit statements regarding the relationship of collative variables, novelty, complexity, incongruity, uncertainty, to information theory. Collative properties of stimuli possess demonstrated motivational significance and play a role in many of the theoretical positions mentioned above.

If information has incentive properties it should serve as reinforcement for learning. Informational situations have been used as reinforcers with both lower animals and children. For example, size and form discriminations were acquired by first and second grade children given the opportunity to connect two dots on a dot drawing after each correct response in a study by Mittman and Terrell (1964). Similarly, young children learned a position alternation sequence equally well with either a candy reward or the chance to look at a novel toy for five seconds (Lintz, Starr and Medinnus, 1965). It would be instructive to measure and manipulate amount of information in reinforcing stimulation. Perhaps there is an optimal amount of reinforcing information, neither too much nor too little, and perhaps the optimal amount changes developmentally.

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Table 1

Information Value and Reward Object Probabilities for Four Independent Groups under Experimental and Control Conditions

Within-S Conditions

Between-S Groups

	Experimental (Uncertainty)				Control		
	N	Bits	Prob. Marble	Prob. Bean	Bits	Prob. Marble	Prob. Bean
50-50 (A)	16	1.0	.50	.50	0	.50	.50
50-50 (B)	16	1.0	.50	.50	0	.50	.50
90-10	16	.47	.90	.10	0	.90	.10
10-90	16	.47	.10	.90	0	.10	.90

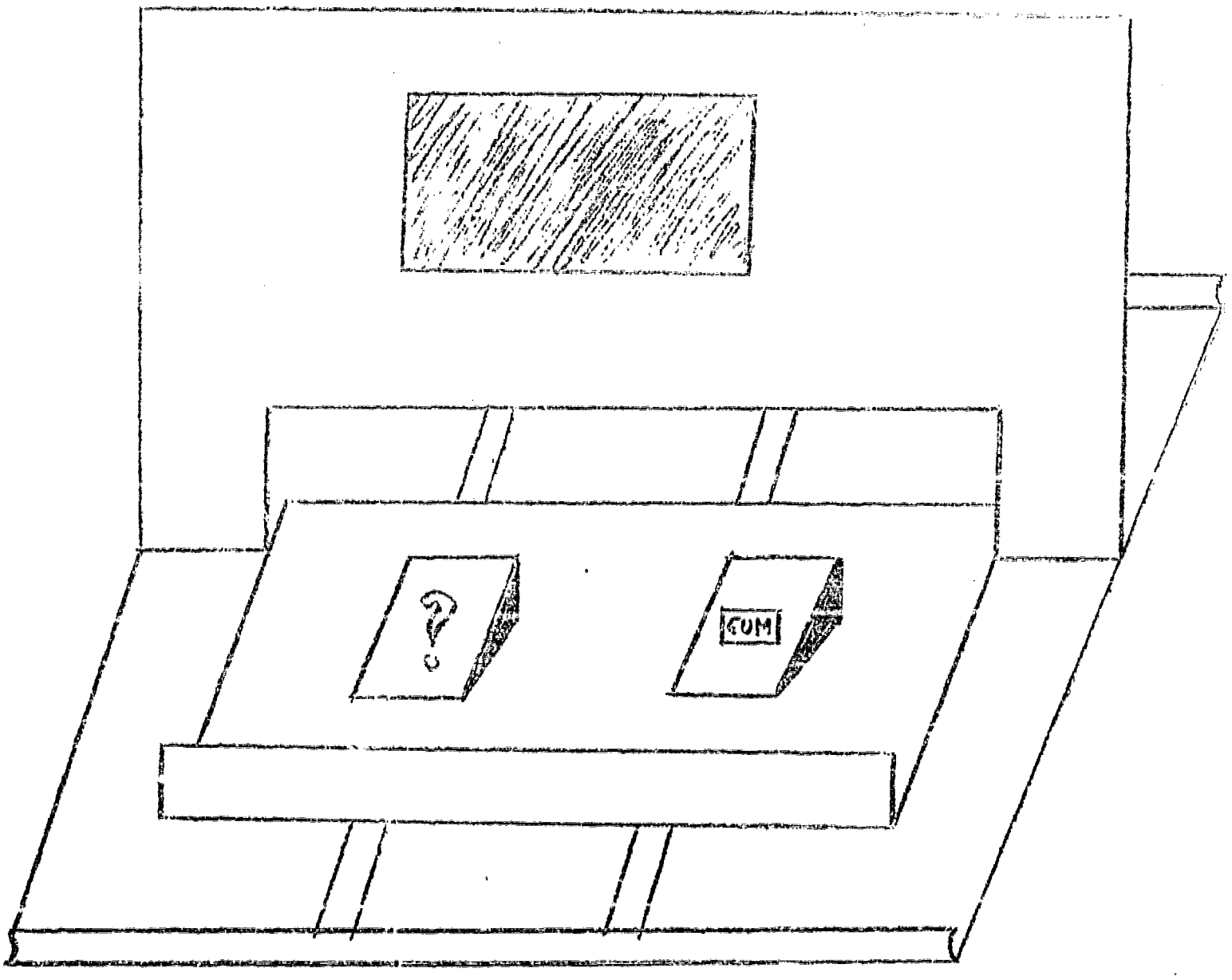

Figure 1. Schematic of modified W.G.T.A. showing stimuli as presented to S.

Table 2

Mean Question Mark Choices and Standard Deviations for Probability Schedule--Reward Distribution Groups under Experimental and Control Conditions

	Between-S Groups			
Within-S Conditions	50-50 (A)	50-50 (B)	90-10	10-90
Experimental				
M	15.69	16.44	20.94	14.25
SD	8.93	7.79	8.66	10.45
Control				
M	12.44	12.31	19.56	10.50
SD	9.80	9.29	9.12	9.88

Note.--Maximum choices per cell = 40; N = 16 per cell.

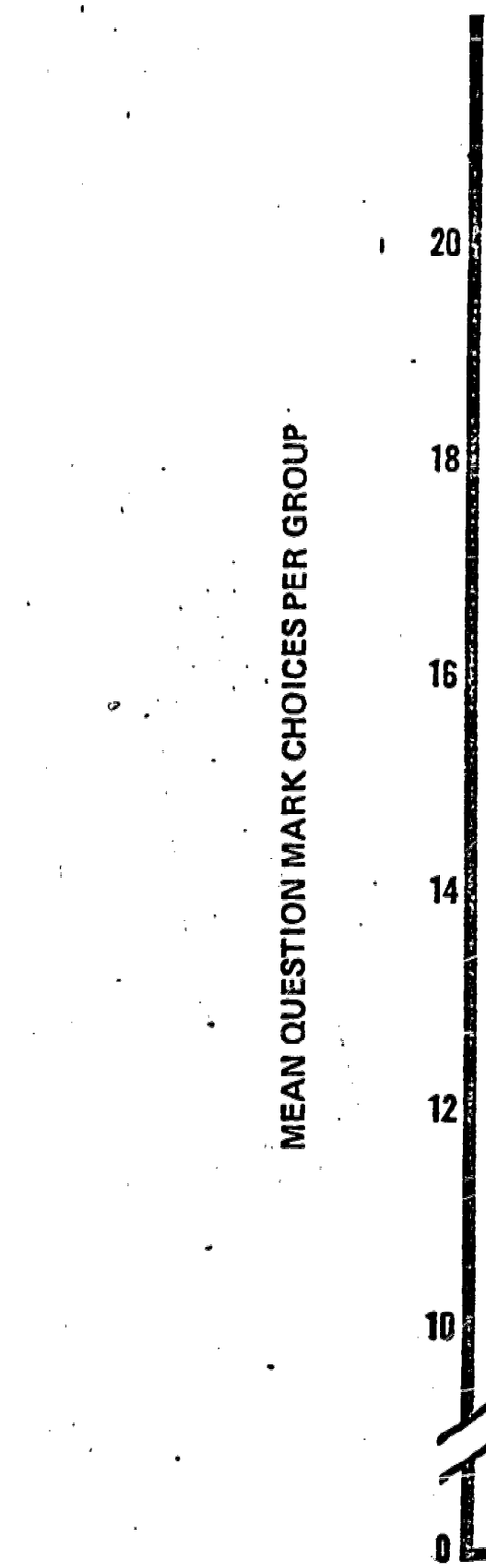

Figure 2. Mea
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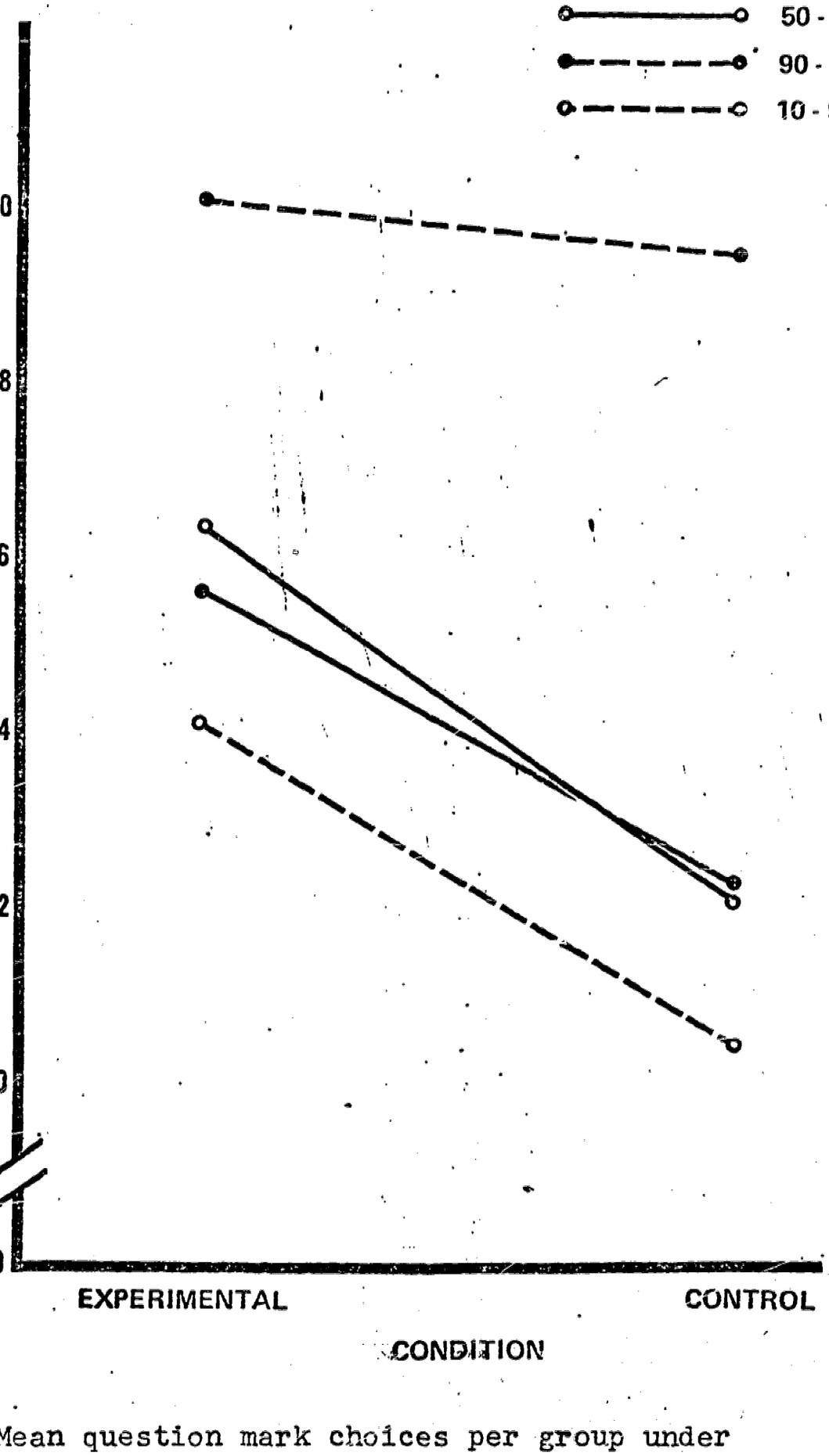

Mean question mark choices per group under
experimental (uncertainty) and control conditions.