

## STRATEGIES OF NORMAL AND MENTALLY RETARDED CHILDREN UNDER CONDITIONS OF UNCERTAIN OUTCOME

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IN studies of behavior in two-choice situations of uncertain outcome the general format has been to present *S* with a series of trials and have him decide on each trial which of two uncertain events will occur. The outcome (occurrence or nonoccurrence of one or the other events) either confirms or negates the *S*'s previous choice. Brunswik's work with rats on choice-behavior in the T-maze (1939) and Humphrey's study with adult humans (1939), in which *S* was instructed to guess whether illumination of one light would follow another, were the first experiments which indicated that response probability in a two-choice situation could be brought under the control of the outcome probability.

Recently, Schusterman (1963) investigated the use of consistent response tendencies or "strategies" as expressed by the conditional response probabilities of adult chimpanzees and three groups of children (ages 3.5 yr., 5.1 yr. and 10.8 yr.) in a two-choice situation consisting of a 50:50 probability series. Although the payoffs from the two alternatives occurred equally often, a patterning effect was produced by varying the first-order conditional probability in the sequence of payoffs. Analysis of conditional response probabilities revealed that series contingencies had their strongest effects on the behavior of the oldest group of children and had little effect on the youngest group. In addition, under certain conditions, each age

group was characterized by different strategies.

The present study was conceived within a comparative psychological framework and was designed to obtain information relevant to the following questions: (a) Are mentally retarded children influenced by variation of the first-order conditional probability in a sequence of payoffs? (b) Are strategies used in a situation of uncertain outcome related to either CA or MA? (c) Are the strategies of mental retardates more stereotyped than those of normals having the same MA?

### METHOD

#### *Subjects*

The *Ss* were institutionalized mentally retarded children (MR) from the Sunland Training Center in Gainesville, Florida. Diagnoses of *Ss* who were tested included familial, unknown etiology, or brain damage associated with cerebral palsy or epilepsy. The criterion for selection was an IQ above 40,

<sup>1</sup> This research was carried out while I was a National Institute of Mental Health Predoctoral Fellow (MF-11,899) at the Yerkes Laboratories of Primate Biology. I would like to formally express my thanks to the cooperative teachers and parents in Orange Park and in Duval County, Florida, and to Mr. R. C. Philips and Dr. Ann Bromley at the Sunland Training Center, Gainesville, Florida, all of whom kindly provided subjects, intelligence test data and facilities for the study. This paper is a revised version of one read at the annual meeting of the American Association on Mental Deficiency in New York City, May, 1962.

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an MA near five years and a CA near 10 years. On this basis, 35 Ss were selected. It was decided that results obtained from Ss who responded to only one position throughout the probability series should be eliminated. The rationale for this procedure was based on the opinion that one could not be certain that such Ss fully understood the instructions. Accordingly, three Ss were dropped from the original data analysis. However, since there was an interest in determining the number of Ss who showed stereotyped choice-behavior, these three Ss were *included* in an analy-

periment may be found elsewhere (Schusterman, 1963), only a brief description will be given here. All Ss were tested with a modified version of the Wisconsin General Test Apparatus. It consisted of a table on which was mounted a sliding opaque screen and movable tray. The stimulus objects were two identical black bottle tops which covered two round pieces of compressed cotton spaced  $7\frac{1}{2}$  in. apart.

The Ss were brought to the testing room by an attendant. After S was seated in front of the apparatus he was told that he could participate in a "candy

TABLE I  
DESCRIPTION OF NORMAL AND MENTALLY RETARDED CHILDREN (AGE IN YEARS)

Group	N	CA			MA			IQ		
		M	SD	Range	M	SD	Range	M	SD	Range
MRs	32	10.1	1.2	7.9-12.2	5.2	.9	4.0-6.7	52.2	8.7	41-73
5-yr.-olds	31	5.1	.4	4.0-5.8	...	..	.....	.....	....	.....
10-yr.-olds	34	10.8	.6	10.0-12.3	...	..	.....	101.8	10.4	82-124

sis dealing with stereotyped response tendencies.

For all but three of the MRs intelligence test data were available from some form of the Stanford-Binet. Two of the Ss had test scores on the WISC, and the other was tested with the Leiter International Performance Scale. These data are summarized in Table I along with the available descriptive data on the normal children. Intelligence data on the normal 10-yr.-olds were available from some form of the Khulman-Anderson Intelligence Test. Intelligence data on the normal 5-yr.-olds were not available and it was assumed that in this case MA was approximately equal to CA. (For further details on normal Ss see Schusterman, 1963.)

#### *Procedure and Apparatus*

Since a detailed description of the apparatus and procedure used in this ex-

periment may be found elsewhere (Schusterman, 1963), only a brief description will be given here. All Ss were tested with a modified version of the Wisconsin General Test Apparatus. It consisted of a table on which was mounted a sliding opaque screen and movable tray. The stimulus objects were two identical black bottle tops which covered two round pieces of compressed cotton spaced  $7\frac{1}{2}$  in. apart. The Ss were brought to the testing room by an attendant. After S was seated in front of the apparatus he was told that he could participate in a "candy game," the object of which was to find a chocolate chip candy under one of the objects as many times as possible. The E emphasized in his instructions and demonstration that the candy would be hidden under one or the other object, but not both. Although some were apprehensive, once they learned the nature of the game and were given a piece of candy, all Ss were strongly motivated to play as evidenced by their frequent requests to play again after testing was terminated.

After E baited a position with the opaque screen down, the screen was raised and the tray moved forward. The S's task was to displace one stimulus object in order to obtain a reward. The noncorrection procedure was used for all Ss. The interval between stimulus presentations was approximately 10-12 sec.

### Experimental Design

The design was similar to that of Goodnow and Pettigrew (1955), i.e., a  $2 \times 2$  factorial with two conditions of initial learning (100% or no training) and two kinds of probability series (Long-Run [LR] 50:50 or Short-Run [SR] 50:50) consisting of 70 trials. Although each of the two stimulus events (reward under right or left object) occurred equally often during the prob-

TABLE II  
TRAINING PHASES FOR EACH CONDITION

Con- dition	Order of Training Phases		
	Pretrain- ing	Initial	Probability Series
100% LR	5 trials	100:00	Long-Run 50:50
100% SR	in which	100:00	Short-Run 50:50
..... LR	either	..	Long-Run 50:50
..... SR	alternative payed off	..	Short-Run 50:50

ability series, a patterning effect was produced by varying the first-order conditional probability in the sequence of reinforcing events. Under the LR series the probability of reward for either side on trial  $n$  was .64, given that a reward occurred at that side on trial  $n-1$ . Under the SR series the comparable conditional probability was .39.

All Ss were given five pretraining trials in which  $E$  baited both positions with reward. The Ss were shifted from one training phase to another without a break. Each S experienced one of the following four training conditions: (a) Initial 100 per cent training, consisting of continuous reinforcement at one position until a criterion of learning was attained (15 consecutive errorless trials), followed by the LR 50:50 series (100% LR). (b) Initial 100 per cent training, followed by the SR 50:50 series (100% SR). (c) The LR 50:50 series without initial 100 per cent training (—LR). (d) The SR 50:50 series without initial

100 per cent training (—SR). Table II presents the order of training phases for each condition. Those Ss given initial 100 per cent training were forced to go to their nonpreferred side as established during the five trials of the pretraining phase.

## RESULTS

### Pretraining

A frequency distribution of spontaneous alternation responses for the five pretraining trials and the first training trial is shown in Table III. The distribution is U-shaped and somewhat skewed toward the higher values. The observed number of MRs tending not to alternate or shift their response at all and those shifting on every trial are considerably greater than would be expected from a rectilinear distribution ( $\chi^2 = 19.8, df = 5, p < .01$ ). These results indicate that, although as a group MRs neither tend toward response alternation nor response repetition, the majority of individuals show an extreme form of one tendency or the other. Whereas the majority of normal 5-yr-olds also showed extreme response alternation (but not response repetition) and the majority of normal 3-yr-olds showed extreme response repetition (but no response alternation), normal 10-yr-olds showed no statistically significant response tendency during the pretraining phase. (See Table I in Schusterman, 1963.)

### Initial Learning

Table IV presents the mean number of trials to reach criterion for each group of Ss (MRs, 5-yr-olds and 10-yr-olds). These results indicate that MRs and normal 5-yr-olds learn a simple positional discrimination significantly

TABLE III  
 FREQUENCY DISTRIBUTION OF SPONTANEOUS  
 ALTERNATION RESPONSES BY MENTALLY  
 RETARDED CHILDREN DURING  
 PRETRAINING

No. of Alternations	No. of Ss
0	10
1	1
2	3
3	2
4	4
5	12
Total	32

more rapidly than do normal 10-yr.-olds ( $F=6.06$ ,  $df=2/50$ ,  $p < .01$ ).

### *Probability Series*

The last 60 trials of the probability series were analyzed in terms of conditional response probabilities. The approach was to tabulate the proportion of choices (on trial  $n$ ) of a previously (trial  $n-1$ ) rewarded position (win-stay strategy) and the proportion of choices which shifted from a previously non-rewarded position (lose-shift strategy). It was expected that some Ss would show a preference for a single position which could be predicted on the basis of all training prior to the last 60 trials of the probability series. In order to determine the effect of this tendency, the actual location of position (right and left) was disregarded and instead positions were categorized as preferred (P) and nonpreferred (NP). Position preference was determined by the algebraic summation of reinforcements and non-reinforcements previously received during pretraining, initial training (if any) and the first 10 trials of the probability series. This method was similar to that used by Spence (1937).

The frequency of P and NP choices following a win or a loss and the proportion of win-stay and lose-shift re-

sponses is given in Table V for all conditions. That the MRs were sensitive to the run-sequence of payoffs was indicated by a significantly greater proportion of lose-shift responses with the P position under the LR conditions than under the SR conditions (Mann-Whitney  $U=73.5$ ,  $p < .05$ ). The effect of the initial training variable was also demonstrated by a significantly greater proportion of win-stay responses with the NP position when Ss received initial training than when they did not ( $U=67$ ,  $p < .05$ ). Examination of Table V also reveals that there was a tendency for these Ss to alternate away from the NP position regardless of success or failure. The effect was especially pronounced under the -SR condition. In addition, it should be noted that, except after choosing the P position under the -SR condition, there is generally a greater percentage of lose-shift responses than lose-stay responses, regardless of which previous position was chosen.

Comparison of the results of MRs with those of normal children (see Table II in Schusterman, 1963) suggest the following: (a) Although MRs appear to be somewhat more sensitive to the experimental conditions than normal 5-yr.-olds, they are not nearly as sensitive as normal 10-yr.-olds. (b) In contrast to normal 10-yr.-olds, MRs and 5-yr.-olds persist less after an unsuccessful than after a successful choice, even under the SR conditions, where such behavior tends to minimize rather than maximize probability of reward. (c) Especially under conditions of -SR, MRs and 5-yr.-olds tend to alternate away from the NP position regardless of success or failure. This tendency was not found in normal 10-yr.-olds.

*Comparison of Strategies Regardless of Experimental Conditions and Pre-*

TABLE IV  
MEANS AND SDs OF TRIALS TO CRITERION  
DURING INITIAL TRAINING PHASE

	Group		
	MRs	5-Yr.-Olds	10-Yr.-Olds
M	11.1	11.3	24.8
SD	13.4	13.7	12.1

*dicted Position Preference.* Since the distribution of Ss from the three samples, is approximately proportional for all experimental conditions (see Table V in this study and Table II in Schusterman, 1963), one way of comparing the samples in terms of their most characteristic strategies is to determine the strongest strategy of any given S regardless of experimental conditions. The approach was to obtain a score for each S with reference to the following categories: (a) *Win-stay, lose-shift.* The tendency to repeat a response to a position which was rewarded on the previous trial and to alternate away from a position which was not rewarded on the previous trial. (b) *Win-shift, lose-stay.* The tendency to alternate away from a position which had just been rewarded, and to repeat a response to the position which had not been rewarded on the previous trial. (c) *Alternation.* The tendency to shift from the response of the previous trial regardless of outcome (success or failure). (d) *Repetition.* The tendency to persevere with the same response as on the previous trial regardless of outcome. (e) *Preference.* A tendency to respond to one position more than another.

Each S, including three MRs and one 5-yr.-old who responded to a single position throughout the probability series, was then classified under one of these five categories. Rather than inflating the N, six Ss having tied scores were dropped from the analysis. Figure 1

TABLE V  
FREQUENCY OF CHOICES OF PREFERRED (P) AND NONPREFERRED (NP) POSITIONS FOLLOWING WIN OR LOSS, AND PROPORTION WIN-STAY AND LOSE-SHIFT RESPONSES FOR MENTALLY RETARDED CHILDREN

Condition	N	Choices on Trial <i>n</i> Grouped on Basis of Outcome on Trial <i>n-1</i>										Total Choices				
		Chose P					Chose NP									
		P	NP	% P	Lost	Won	P	NP	% NP	Lost	Won	P	NP	% P	P	NP
100% LR	9	120	46	72	95	21	82	83	44	65	93	38	71	278	262	52
100% SR	8	56	54	51	80	51	61	59	53	53	78	49	61	238	242	50
..... LR	8	43	70	38	98	36	73	51	73	41	93	16	85	245	235	51
..... SR	7	73	62	54	62	71	47	8	68	11	57	19	75	269	151	64

Note: Data for Trials 11-70 of 50:50 period.

depicts the results of this analysis and shows that although the win-stay, lose-shift measure did not differentiate the samples, all other measures did. More than 30 per cent of the MRs and normal 5-yr.-olds were classified as "alternators" and more than 30 per cent of the MRs and 15 per cent of the normal 5-yr.-olds responded primarily on the basis of position preference. In contrast, less than 20 per cent of the normal 10-yr.-olds were "alternators" and less than 5

being extremely sensitive to the run-sequence of payoffs, use strategies which are primarily determined by the outcome contingencies, most MRs and normal 5-yr.-olds, being less sensitive to the run-sequence, tend to employ strategies based on factors other than the outcome contingencies ( $\chi^2=5.56, df=2, p=.07$ ).

*Sterotyped Strategies.* In order to determine whether strategies of MRs were more sterotyped than those of normal children, Ss from all three samples were

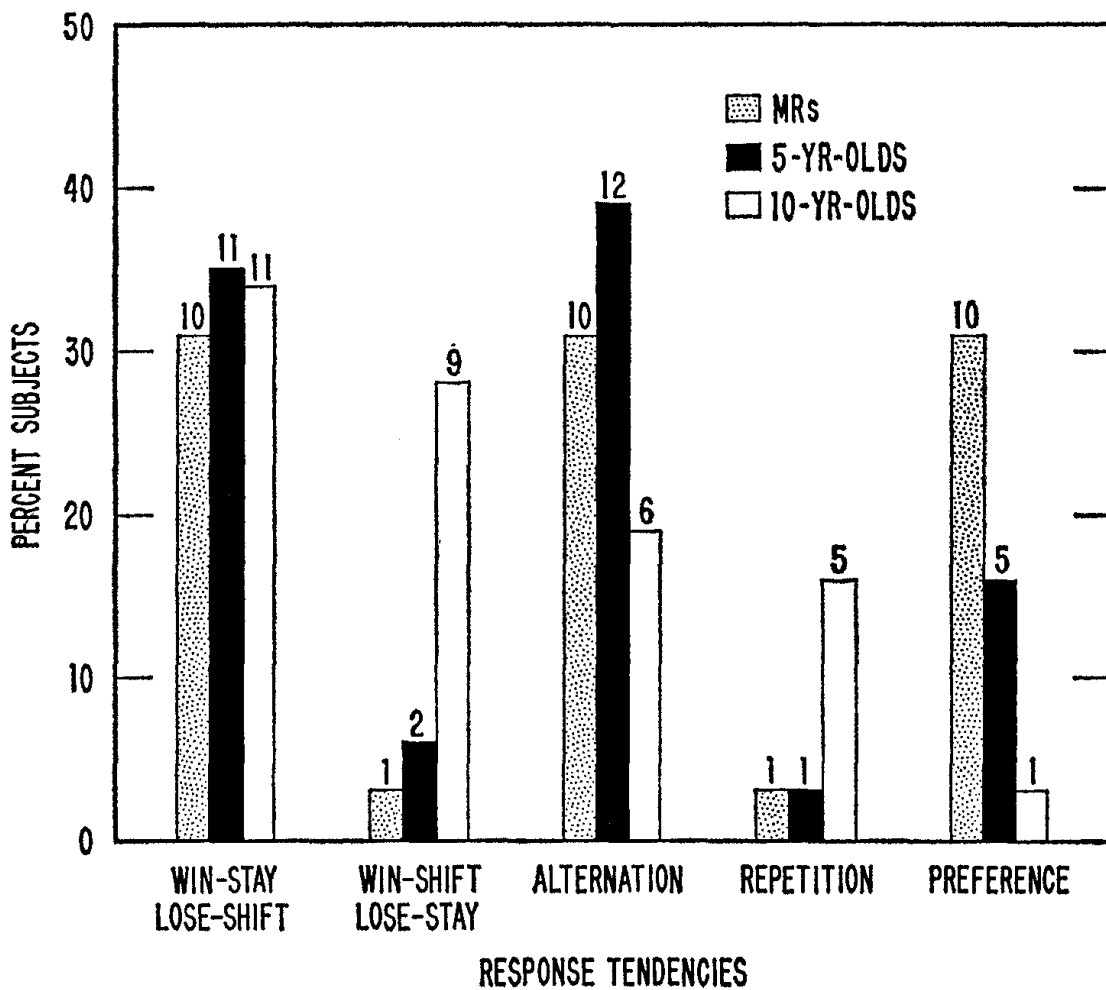


FIGURE 1

per cent had a strong position preference. Rather, the bulk (63%) of the 10-yr.-olds had either a relatively strong win-stay, lose-shift strategy or win-shift, lose-stay strategy. It appears, therefore, that whereas most normal 10-yr.-olds,

classified as having a sterotyped strategy if 41 or more of their responses (41 of 60 yields a  $p=.01$  by a binomial test) fell under one of the following five categories (win-stay, lose-shift; win-shift, lose-stay; alternation; repetition; prefer-

ence). Table VI presents the results of this analysis and it is quite apparent that the MR and 5-yr.-old groups contain most of the Ss having stereotyped strategies. Although the analysis indicated no statistically significant difference between MRs and normal 5-yr.-olds on this measure, the measure did significantly differentiate between MRs and 10-yr.-olds ( $\chi^2=25.5$ ,  $df=1$ ,  $p<.001$ ) and 5-yr.-olds and 10-yr.-olds ( $\chi^2=10.4$ ,  $df=1$ ,  $p<.01$ ).

TABLE VI

FREQUENCY DISTRIBUTION OF SCORES EQUAL TO OR GREATER THAN 41 DURING TRIALS 11-70 OF 50:50 PERIOD

Score	Group			Total
	MRs	5-Yr.-Olds	10-Yr.-Olds	
$\geq 41$	31	25	12	68
$< 41$	1	6	20	27
Total	32	31	32	95

## DISCUSSION

Previous research (Schusterman, 1963) showed that in two-choice situations of uncertain outcome, strategies of normal 5 and 10-yr.-old children, but not normal 3-yr.-old children and chimpanzees, may be affected by the run-sequence of payoffs or reinforcing events. The present study has demonstrated that strategies of mentally retarded children, having a mean CA near 10 yr. and a mean MA near 5 yr., are also affected by the run-sequence of reinforcing events. Within the framework of probability learning this means that MRs have the ability to respond to patterns of reinforcement rather than reinforcement frequency alone (cf., Stevenson & Zigler, 1958).

Earlier findings indicated that the kind of strategy used in a two-choice 50:50 probabilistic task was, among

other factors, a function of CA. The possibility of IQ as a significant determiner of strategies in this kind of task would seem to be ruled out, since all age groups except the MRs were of normal intelligence. Rather, the results of the present study point strongly to the hypothesis that strategy development in two-choice situations of uncertain outcome is a function of intellectual maturity or MA. Tables IV and VI and Figure I and a comparison of Tables III and V of this study with Tables I and II of a previous study (Schusterman, 1963) show how similar all children with an MA of 5 yr. are, regardless of their CA, and how different they are from children with an MA of 10 yr.

More specifically, results from the pretraining phase showed that MRs and 5-yr.-olds had a strong initial tendency to alternate without regard to outcome. This tendency persisted throughout the 50:50 probability series. In addition, both MRs and 5-yr.-olds were strongly influenced by a position preference throughout the probability series. Neither of these tendencies were manifested to any considerable extent in the two-choice behavior of 10-yr.-old children.

Results indicating that strategies of MRs and 5-yr.-olds (as expressed by conditional response probabilities) are stronger or more stereotyped than those of 10-yr.-olds suggest that going back a single trial is more characteristic of the strategies of intellectually immature Ss than of the strategies of more intellectually mature Ss. Apparently the decision-behavior of 10-yr.-olds is similar to that of adults in that a choice on any given trial  $n$  is determined not so much by the outcome and choice on trial  $n-1$  but by previous outcomes and choices extending back a great number of

trials. For example, a lengthy run of payoffs from alternative  $A_1$  tends to increase the probability that college students will choose alternative  $A_2$ . This phenomenon was found by Jarvik (1951), who called it the "negative recency effect" or the "gambler's fallacy." The notion that response tendencies of high MA Ss are less stereotyped than those of low MA Ss is also supported by the results of the pretraining phase (see Table I in Schusterman, 1963). Pretraining data suggest initial complex pattern seeking by 10-yr.-olds. These results would seem to have important implications for those statistical learning models dealing with the conditional probability situation (cf., Anderson, 1960).

The finding that MRs and 5-yr.-olds learn the initial positional discrimination task at the same rate, a rate which is significantly faster than that of 10-yr.-olds, would seem paradoxical without the notion of strategies and payoff patterns. It seems reasonable to hypothesize that any regular payoff pattern or strategy (these cannot be differentiated during pretraining), e.g., alternation and repetition, should have been highly discriminable from the 100 per cent payoff pattern which confronted MRs and 5-yr.-olds during the initial training phase. In contrast, the complex pattern seeking exhibited by 10-yr.-olds produced an irregular payoff pattern during the pretraining phase, which should have interfered with the learning of the 100:00 pattern of the initial training phase.

The foregoing hypothesis has a great deal of support from the literature on the Partial Reinforcement Effect (Lewis, 1960). In addition, if high MA Ss are more likely to be characterized in their choice-behavior by the "gambler's fal-

lacy" than are low MA Ss, then this tendency should also be reflected by a slower rate of learning of a simple positional discrimination. This interpretation is consonant with the hypothesis formulated by Weir and Stevenson (1959) when they found a decrease in the rate of learning a simple visual discrimination with increasing CA. They interpreted their results as indicating that older Ss have a greater repertoire of complex strategies than Ss below their intellectual development and that these strategies interfered with problem solution. Results such as these are interesting and point out the fallacy of using a simple learning task to differentiate groups and then concluding that the group that performs best is the intellectually superior group.

Results regarding the finding that low MA Ss persist less with a previously unsuccessful choice than do high MA Ss is consistent with Rosenzweig's findings (1933). He found that whereas older children (10-14 yr.) more often choose an unsuccessful puzzle to repeat than a successful one, younger children (5-9 yr.) do the reverse. In a more general way, these findings are related to the notion that, until asymptote is reached, level of aspiration is an increasing function of maturation.

It would certainly appear then that high MA Ss have a greater tolerance for successive nonrewarded trials than do lower MA Ss. This difficulty that low MA Ss have in inhibiting the tendency to shift from a previously nonrewarded choice has also been found in rhesus monkeys (Wilson, 1962), gibbons (Schusterman & Bernstein, 1962), and chimpanzees (Schusterman, 1963), and may be a significant factor in producing inappropriate response tendencies, e.g., response alternation and position pre-



ference, under conditions of a short run-sequence of payoffs. Further, since the LR patterns generally produced a strong win-stay, lose-shift strategy for both low and high MA Ss, it is suggested that this outcome-contingent strategy is more primitive than a win-shift, lose-stay strategy. Certainly this notion is consistent with those findings demonstrating that under conditions where the run-sequence of events is similar or identical, rats (Overall & Brown, 1959), chimpanzees and 3-yr.-old children (Schusterman, 1963), employ a win-stay, lose-shift strategy, whereas older children (Schusterman, 1963) and college students (Goodnow & Pettigrew, 1955; Overall & Brown, 1959), employ a win-shift, lose-stay strategy.

#### SUMMARY AND CONCLUSIONS

A group of mentally retarded children (Mean CA=10.1; Mean MA=5.2) was compared with two groups of intellectually normal children with respect to their two-choice behavior in a situation consisting of a 50:50 probability series. One group of normal children was matched with the retardates on the basis of CA (10.8 yr.) and the other normal group on the basis of MA (5.1 yr.) The experimental design was a 2 x 2 factorial with two conditions of initial learning (100% or no training) and two kinds of probability series (Long-Run 50:50 [conditional probability=.64] or Short-Run 50:50 [conditional probability=.39]) consisting of 70 trials. Choice-behavior during the 50:50 probability series was analyzed in terms of conditional response probabilities.

The following results were reported: (a) Although all groups of children were differentially affected by the run-sequence of events, initial training and

series contingencies had their strongest effects on the behavior of the most intellectually mature group. (b) Whereas low MA Ss tended to alternate without regard to outcome or show a strong position preference during the probability series, high MA Ss did not. (c) In contrast to high MA Ss, low MA Ss persisted less after an unsuccessful choice than after a successful choice, even under the Short-Run conditions, where such behavior tends to minimize rather than maximize reward probability. (d) Strategies of low MA Ss were more stereotyped than those of high MA Ss. (e) Learning rate of an initial positional discrimination was inversely related to MA.

The following conclusions were drawn: (a) Strategies used in a situation of uncertain outcome are related to intellectual development. (b) Whereas Ss attaining an MA of 10 yr. are likely to make a choice based on outcomes and choices extending back more than a single trial, less intellectually mature Ss with an MA of 5 yr. or less are more likely to make a choice based on the outcome and choice of the preceding trial.

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