Developmental changes in level of achievement as a function of magnitude and direction of cue validity

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DEVELOPMENTAL CHANGES IN LEVEL OF ACHIEVEMENT
AS A FUNCTION OF MAGNITUDE AND DIRECTION OF CUE VALIDITY

A Thesis
Presented to the
Department of Psychology
and the
Faculty of the Graduate College
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In Partial Fulfillment
of the Requirements for the Degree
Master of Arts

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Abstract

Twelve groups of Ss participated in a probability learning task which was derived from Brunswik's Lens Model. The groups varied according to age (7-8, 13-14, and 19-20 year olds), magnitude (.40 and .80), and the direction (positive and negative) of the ecological validity coefficient (cue-criterion correlation). The Ss were required to predict a two-digit criterion number after viewing a two-digit cue value. An analysis of cue utilization (S's response-cue correlation) and achievement (S's response-criterion correlation) revealed that Ss had much more difficulty dealing with cues which have a negative, rather than a positive, relationship with the criterion. Some evidence also was obtained indicating that children (7-8 years old) tend to copy the cue more often than adults.
Introduction

Children live and function within environments (home, school, playground, etc.) which are probabilistic in nature. They learn that not every act or response has the same consequence 100 per cent of the time. For example, a "favorable" response is not always followed by a reward; at times it goes unnoticed. Therefore, to investigate behavior in a real-life (probabilistic) experimental situation the child must be presented a task in which the probability of a particular stimulus occurring is less than one, i.e., the "correct" response is rewarded according to a partial schedule of reinforcement.

The experimental situation most often used in the investigation of probability learning involves a task requiring a choice between two or three alternatives with a marble reward. The child is told to select one of the buttons before him, and if he makes the "correct" choice he will receive a marble as a reward. The "correct" button, however, is rewarded according to a prearranged variable-ratio schedule of reinforcement. The other alternative(s) receives fewer rewards than the "correct" one. The task is probabilistic in the sense that for any one trial, regardless of alternative selected, the child may or may not receive a reward. What makes it suitable for the investigation of probability learning
is the uncertainty of being rewarded.

It has been shown that, during initial trials of a probability task (Stevenson & Weir, 1963; Weir, 1964; Weir, 1967), adults, adolescents, and pre-adolescents tend to match their response frequency to the reward probabilities of the response alternatives. For example, on a task with two alternatives, one of which is reinforced 66 per cent of the time and the other 33 per cent of the time, adults will select the most frequently reinforced alternative 66 per cent of the time and the other alternative 33 per cent of the time. This pattern of responding is so common in probability learning that it has been called a probability matching strategy. Non-primary children maintain this response strategy throughout the task, i.e., probability matching is also their terminal strategy.

Preschool children and primary grade children use a different strategy. When presented with the task described above, these children tend to select exclusively the alternative which is most often rewarded (Jones & Liverrant, 1960; Stevenson & Weir, 1963; Weir, 1964). This response pattern, which allows the child to receive the greatest number of rewards, is called a probability maximizing strategy. Weir (1964) has found that although adults may initially use a probability matching strategy, they soon change to a probability maximizing strategy.
Research has demonstrated that these strategies appear across species. For example, rats, when faced with a two-choice probability task, will adopt a probability maximizing strategy (Bitterman, Wodinsky, & Candland, 1958; Lehr & Pavlik, 1970). Fish, on the other hand, will adopt a probability matching strategy (Bitterman et al., 1958).

Often the results of studies performed on the probability learning of children are taken as information about cognitive behavior (see Harper, Anderson, Christensen, & Hunka, 1964). However, the fact that animals adopt the same strategies as humans suggests that investigations which have used response alternatives as a measure of cognitive behavior are studying response strategies rather than cognitive strategies. If statements are to be made concerning a child's functioning in a probabilistic environment, analysis of behavior in terms of response strategies is totally inadequate. Response strategies may be due to response perseveration or response alternation and not the child's utilization of probabilistic information. An approach which may not be liable to the aforementioned criticism is offered by Brunswik's Lens Model (1956).

Basic to Brunswik's probabilistic functionalism is the concept that the organism functions in a probabilistic environment. The individual's behavior is the result of inferences made on the bases of probabilistic (environmental) data. Brunswik (1952) used a lens model to describe the re-
relationships between the variables, the environment, environmental cues, and the individual, involved in his concept of probabilistic functionalism (see Figure 1).

Briefly, Brunswik proposed that an individual's environment (ecology), or some variable of it, will be presented to him as a pattern of cues, and that on the basis of this pattern of cues he can predict his environment. Each cue in the pattern, which may consist of one or more cues, covaries with the ecological variable to be predicted, and the degree of covariation between these elements defines the ecological variable to be predicted. When presented with this pattern of cues \( r_{ei} < 1 \), for all \( i \) the individual must adopt some probabilistic strategy which will enable him to make the "best" inference he can about his ecology. The degree to which these cues are utilized by the individual is measured by the correlation between a cue and the weight assigned to that cue by the individual; this correlation defines cue utilization \( r_{si} \). The correlation between the ecological variable and the individual's estimate of that variable is a measure of functional validity \( r_a \); this is the individual's degree of achievement with respect to the ecological variable.

There are several advantages to the Brunswikian approach. First, the problems of response perseveration and response alternation probably do not occur. There is the possibility, however, that children may demonstrate a cue bias. Second,
Fig. 1. Brunswik's Lens Model
correlation techniques enable the researcher to specify the exact environmental intercorrelations (ecological validities and intercue validities) and a quantitative measure of an individual's cue utilization and achievement.

The typical paradigm used in investigations based upon Brunswik's Lens Model involves presenting to a S, on each trial, one or more cues and then asking the S to predict some criterion; the cues, the criterion, and the prediction are all on an interval continuum, and are usually two-digit numbers.

One of the first studies to use Brunswik's Lens Model in an experimental situation was by Peterson, Hammond, and Summers (1965). They used three single-digit cues and a single-digit criterion. The cues and criterion had a positive linear relationship with ecological validities of .50, .33, and .17. They found that the performance of adults tended to approach an optimal performance, as defined by the extent of the ecological validity correlation.

Dudycha and Naylor (1966) used two, two-digit cues and a two-digit criterion. Both cues were linearly related to the criterion, and were, singularly and combined, probabilistic in nature. They found that the S's level of achievement was a function of the ecological validity of the cues, and that the greater the discrepancy between the cues with respect to ecological validity, the lower the level of achievement. If
two cues are associated such that the first has the higher ecological validity, then the S's level of achievement decreased below that of the high validity cue alone. On the other hand, if the first cue had a low validity, then the S's performance would increase with increases in second cue validity to a level at or above that expected for the first cue alone.

Whereas the cited studies dealt with multiple-cue paradigms and adult Ss, the Deffenbacher and Hamm (1972) study used a single-cue paradigm with children and adults. The cue and criterion values were two digit numbers with ecological validities of .80 and .40. They found that Ss in the high cue condition attained a higher level of performance than Ss in the low cue conditions, and that the level of performance of 7-8 year olds was only slightly above that of 19-20 year olds, with both groups superior to that of 13-14 year olds.

Another study which used a single-cue paradigm is that of Naylor and Clark (1968). They used two-digit numbers for both cue and criterion and both positive and negative ecological values which varied from -.80 to +.80 in steps of .20. There was a linear relationship between cue and criterion values. The results of their study showed that, although the rate of learning was the same for both positive and negative
cue validities, the assymptote for achievement with positive cues was superior to that with negative cues. As in other studies, achievement was also found to be a function of level of cue validity.

Statement of the Problem

The writer sought to study the effect of age on the level of achievement in a one-cue probabilistic environment with both positive and negative ecological cue validities.

Hypotheses

White (1965) has indicated that young children tend not to process stimuli (e.g., develop inferences, hypothesis, and verbal mediators) which are presented to them, rather than respond directly to the stimuli; that is, they are stimulus-bound. They will respond to the stimuli without mediation, which in the present context suggests that children will simply copy the cues rather than develop complex hypotheses about them. Based upon White's paper and the results from cited literature, three hypotheses were proposed.

1. Since level of achievement was found by Naylor and Clark (1968) to be higher for positive $r_e$ values than for negative $r_e$ values, hypothesis 1 predicted that children and adults learning positive $r_e$ relationships would obtain a higher level of achievement ($r_a$) than children and adults learning negative $r_e$ relationships.

2. Since Deffenbacher and Hamm (1972) found that children achieve a higher level of performance than adults, hypothesis 2 predicted that children learning positive $r_e$ relationships would reach a higher level of achievement than children and perhaps
even adults learning positive \( r_e \) values.

3. Since children tend to copy the cue values more
then adults, hypothesis 3 predicted that children learning
negative \( r_e \) relationships would have a lower level of achieve­
ment than adults learning negative \( r_e \) relationships.

Method

Subjects. Eighty public school children from grades
two and eight of the Ralston Public Schools, Ralston,
Nebraska, and 40 students from a general psychology course
at the University of Nebraska at Omaha were used as Ss. The
university students participated in this study as partial
fulfillment of a course requirement. Forty Ss from each age
group, 7-8, 13-14, and 19-20 year olds, were assigned random­ly to each of the four experimental conditions, which were
defined by using ecological validities of +.80, -.80, +.40,
and -.40.

Apparatus. For each condition, the cue \( (X) \) and the
criterion \( (Y_e) \) were printed on a roll of program paper. The
tape was then loaded into a Modern Teaching Associates MTA-100
teaching machine so that only one frame was visible. Each
trial required two frames of the tape; the first frame, cue
presentation, contained the cue value alone, and the second
frame, criterion presentation, contained the cue value and the
criterion value.

The Ohio State Correlated Score Generation Method described
by Wherry, Naylor, Wherry, and Fallis (1965) was used to generate
the cues and criterion with prescribed relationships between cues and criterion. The empirical $r_e$ values were within .04 of the theoretical values.

**Procedure.** The $S$s were seen in pairs and seated so that there was no visual contact between them. Each $S$ was seated before the teaching machine and given instructions (see Appendix A) as to the nature of the task. The $S$ was given five practice trials. He was told that his task was to predict a two-digit number ($Y_s$) for each two-digit number ($X$) that he was shown, and that after he had made his prediction he would be shown the "best" number ($Y_e$) he could have predicted. He was told that he was not expected to make accurate predictions on every trial. The $S$ was given no further information concerning the task. He pressed a button on the machine to bring the cue presentation into view. He then wrote his prediction ($Y_e$) on an answer tape which advanced with the programmed tape. Next he pressed the button to bring the criterion presentation into view. The next trial began when the $S$ pressed the button to advance the tape to the next cue presentation. Each trial, which required approximately 20 seconds, consisted of three steps: (1) displaying the cue ($X$); (2) $S$'s recording of his predictions; (3) displaying the cue and the criterion ($Y_e$). Each $S$ completed 100 experimental trials. All of the experimental groups followed the same procedure.
Results

For each of the four trial blocks, two correlation values were calculated and converted to Fisher $Z'$ scores. The S's responses ($Y_s$) were correlated with the criterion values ($Y_e$), resulting in an achievement correlation ($r_a$), and with the cue values ($X$), yielding a cue utilization correlation ($r_s$). Converting the correlation scores to Fisher $Z'$ values was done to normalize the correlation score distributions (Edwards, 1967).

Whereas the reported ecological validity values were predetermined and extended over 100 trials, each trial block of 25 trials contained correlations which varied slightly from the overall value. Since the S's achievement is a function of the ecological validity, which fluctuated from one trial block to the next, his $Z'$ scores were corrected to take into account this fluctuation (Deffenbacher and Hamm, 1972). A ratio was calculated to obtain the corrected achievement $Z'$ score for each trial block. The ratio $Z'$ score for achievement was established by taking the ratio of achievement $Z'$ value to ecological validity $Z'$ value for each 25 trial block.

The Ss' achievement ratio $Z'$ scores indicated the extent to which their achievement $Z'$ scores approximated the amount of environmental information available in each trial block. For example, a ratio of .50 would indicate that S's achievement was .50 of the total amount of environmental predictability.
The corrected achievement and cue utilization scores were analyzed separately using a $3 \times 2 \times 2 \times 4$ repeated measures analysis of variance design having three levels of age (7-8, 13-14, and 19-20 years old), two levels of cue validity (.80 and .40), two levels of cue validity direction (positive and negative), and four blocks of trials ($N = 25$).

**Corrected Achievement Analysis**

**Age.** The mean ratio $Z'$ scores for $S$s 7-8, 13-14, and 19-20 years old were .43, .32, and .26, respectively. Although the main effect for age was not statistically significant, a trend analysis indicated that there was a significant linear component to the main effect ($F = 5.64$, $df = 1/108$, $p < .025$). Therefore, the best fitting straight line through the age function had a negative slope significantly different from zero. The quadratic component was nonsignificant.

**Re Direction.** The main effect for direction of $r_e$ gave a statistically reliable $F$ of 35.04, $df = 1/108$, $p < .001$. The mean ratio $Z'$ score for the positive-cue condition was .51, and .17 for the negative-cue condition. Hence, $S$s found it more difficult to use negative relationships. Achievement scores for those in the negative-cue condition approximated only .17 of the environmental predictability contained in the cue pattern, whereas fully .51 of the predictability was approximated by the $S$s in the positive-cue condition.
**Age x r_e Magnitude.** Though the interaction effect of age and r_e magnitude was not significant, a trend analysis indicated that there was a statistically significant linear component to the interaction effect of age and r_e magnitude ($F = 4.92, df = 1/108, p < .05$). The quadratic component was nonsignificant. The achievement ratio $Z'$ means for the .80- and .40-cue conditions are plotted across age levels in Figure 2. The figure illustrates the continuous decrease in achievement across age for the .80-cue condition. For the .40-cue condition, there was a slight decrease in performance from the youngest Ss to the 13-14 year old Ss followed by a slight increase in performance by the adults. The configuration of the .80- and .40-cue condition curves suggest a linear pattern of change across age.

No other main or interaction effect was significant for the corrected achievement scores.

**Cue Utilization Analysis**

**Age.** The main effect for age yielded a statistically significant $F$ of $6.81, df = 2/108, p < .005$. The mean $Z'$ scores for the 7-8, 13-14, and 19-20 year olds were .69, .53, and .34, respectively. A trend analysis indicated a significant linear ($F = 13.61, df = 1/108, p < .001$) component. Therefore, the youngest Ss used the cues to a greater extent than either of the other two age groups, with the oldest Ss using them the least. No significant quadratic trend was found.
Fig. 2 Interaction of age and cue magnitude for the corrected achievement measure.
**r_e Direction.** The mean $Z'$ value for the positive-cue condition was .82, and .21 for the negative-cue condition. The main effect for $r_e$ direction gave a statistically significant $F$ of 61.87, $df = 1/108$, $p < .001$. Hence, the Ss placed greater emphasis on cues which had a direct relationship with the environment. A cue which had a positive relationship to the ecology was relied upon to a much greater extent than one which had a negative relationship.

**Age x r_e Magnitude.** Figure 3 presents the significant age x $r_e$ magnitude interaction ($F = 4.64$, $df = 2/108$, $p < .025$). Inspection of the figure indicates that while the level of performance in the .80-cue condition decreased dramatically with age, there was only a slight change (.07 mean $Z'$ units) with age in the .40-cue condition. A simple interaction effects analysis of the effect of age at different levels of $r_e$ magnitude yielded a statistically significant age difference for the .80-cue condition ($F = 11.31$, $df = 2/108$, $p < .001$); the $F$ ratio for the .40-cue condition was non-significant. Apparently age is an important predictor of cue utilization only when the $r_e$ value is relatively large. In addition, a trend analysis indicated that there is a statistically significant linear component to the interaction effect of age and $r_e$ magnitude ($F = 9.21$, $df = 1/108$, $p < .005$).

**Age x Trial Block.** The interaction of age and trial block yielded a significant $F$ of 2.70, $df = 6/324$, $p < .025$. 
Fig. 3. Interaction of age and cue magnitude for the cue utilization measure.
Figure 4 presents the mean $Z'$ values for the 7-8, 13-14, and 19-20 year old groups. The configuration of the learning curve for the oldest Ss shows a slight difference (.02 mean $Z'$ units) between the first and fourth trial blocks, with a maximum deviation of only .05 units. The youngest Ss decreased their cue utilization from a peak on the first trial block to a low point on the fourth trial block, with only a slight increase (.06 mean $Z'$ units) from the second to third trial block. The intermediate Ss increased their performance from a low point on the first trial block to a peak on the fourth trial block, with no change from the second to the third trial block.

Re Direction x Trial Block. The interaction effect was statistically significant ($F = 4.10, df = 3/324, p < .01$).

Figure 5 presents the mean $Z'$ values for the positive- and negative-cue conditions across trials. The Ss given the cues with a positive relationship to the criterion decreased their reliance on the cues from the first to the second trial block, followed by an increase in cue utilization across the third and fourth trial blocks. In contrast, those Ss in the negative-cue condition increased their cue utilization from the first trial block to the second, followed by a decrease across the third and fourth trial blocks.

Re Magnitude x re Direction x Trial Block. The mean $Z'$ values for the interaction effect ($F = 3.80, df = 3/324$,
Fig. 4. Interaction of age and trial blocks for the cue utilization measure.
Fig. 5. Interaction of cue direction and trial blocks for the cue utilization measure.
are presented graphically in Figure 6. For each of the cue conditions the level of cue utilization on the first and fourth trial blocks were virtually the same; the largest difference was only .04 units (for the -.80 condition). The variability over the second and third trial blocks was much greater, however. The maximum deviation in the positive-cue condition was .17, and .23 in the negative-cue condition.

No other main effect or interaction was significant except the four-way interaction ($F = 2.67$, $df = 6/324$, $p < .05$).

Discussion

The primary purpose of this study was to determine the effect of age on achievement in an ecology which contained cues that had both positive and negative relationships. Specifically, it was hypothesized that Ss given cues which were positively related to the environment would have a higher level of achievement than Ss given cues which had a negative relationship. The results confirmed this hypothesis.

That the positive relationship between the criterion and the cue pattern was much easier for Ss to learn than was the negative-rele relationship supports the findings of Naylor and Clark (1968). The explanation of this is not obvious, however, since cues in the negative condition imparted as much information, in an absolute sense, as those in the positive-
Fig. 6. Interaction of positive (a) and negative (b) cue direction, cue magnitude, and trial blocks for the cue utilization measure.
cue condition. It would seem that weighting cues which have a negative relationship with the environment would constitute a much more difficult cognitive task if the cue pattern had to be reversed to make the best guess. Such a result could be due to a cultural bias toward positive relationships. Indeed, throughout the school years, children are taught that high (scores) goes with high (achievement), medium (scores) with medium (average achievement), and low (scores) with low (achievement).

A consideration of some of the achievement and cue utilization $Z'$ means illustrates the great difficulty $S$s experienced in the negative-cue condition. The mean ratio $Z'$ score for achievement, .166, for $S$s in the negative-cue condition was not significantly different from zero ($p > .10$), indicating that after 100 trials their level of performance was no better than would be expected by random guessing. If the $S$s were utilizing the cues appropriately, the mean $Z'$ value for cue utilization for the negative-cue condition would be negative. In other words, $S$s who saw a large cue value should have responded with a low prediction. The obtained value, however, was a significant ($p < .05$), positive .214. Hence, the $S$s were persistent in regarding the negative relationship as positive. In fact, their improvement from the first trial block to the last was only .01 mean $Z'$ units (see Figure 5). On the other hand, the facilitating effect of the positive-mental set for the $S$s in the positive-cue con-
dition was indicated by the significant \((p < .001)\) corrected achievement score of .513. These Ss found that the relationship was as they had expected, that is, positive. Likewise, the mean \(Z'\) value for cue utilization was a significant \((p < .001)\) .824.

The other hypotheses predicted an age \(x r_e\) direction interaction effect. Specifically, the second hypothesis stated that children in the positive-cue condition would attain a higher level of achievement than adults in the same condition. Hypothesis three predicted that adults in the negative-\(r_e\) condition would reach a higher level of achievement than children. Since the age \(x r_e\) direction interaction effect was not found to be significant for corrected achievement, neither of these hypotheses could be confirmed. However, a simple interaction effects analysis offers some indirect support for the third hypothesis. A simple effects analysis of the age \(x r_e\) direction interaction for the cue utilization measure yielded a significant age difference for the negative-cue condition \((F = 4.71, df = 2/108, p < .025)\). Hence, when the relationship between the cue and criterion values was negative, the youngest Ss utilized the cue significantly more often than either of the other two age-groups, with the cue utilization value for the oldest Ss significantly lower than that of the intermediate age Ss. The mean \(Z'\) values for the 7-8, 13-14, and 19-20 year old Ss in the positive-cue condition
were .936, .901, and .635, respectively, and .443, .155, and .044, respectively, in the negative-cue condition. All other simple effects for the interaction of age and re direction were nonsignificant.

Although the other two hypotheses were not confirmed, the basis upon which they were predicated, that children tend to copy the cue more often than adults, was supported. Specifically, a one-way analysis of variance was performed on the number of cues copied, that is, the number of times the S used the cue value as his prediction, for the three age groups, 7-8, 13-14, and 19-20 year olds, yielding a significant F of 3.70, df = 2/117, p < .05. In addition, a trend analysis yielded a significant linear component (F = 7.21, df = 1/117, p < .01) with a negative slope. These results indicated that age accounted for a significant portion of the total variance and that the children did, in fact, copy the cue more often than the adults.

The younger child's greater tendency to copy the cue was also reflected in the main effect of age in the cue utilization analysis. A similar, but nonsignificant, age difference was found for achievement. Whereas the relationship between age and performance was found in the Deffenbacher and Hamm (1972) study to be U-shaped, the results of this study indicated that the relationship was linear, with a negative slope. However, little more can be said about the main effect of age in the present study since achievement and cue utilization correlations
were averaged across the cue direction conditions.

Surprisingly, the analysis of cue utilization revealed that as the relationship between the cue and criterion increased, college students relied less on the cue for making judgements (see Figure 3). Again, a similar, but non-significant, interaction effect was found for the achievement measure. In an attempt to determine the cause of this effect, a post hoc analysis of the age x cue magnitude x cue direction interaction means for cue utilization was performed. A series of t tests indicated that in the -.80 condition 7-8 year olds utilized the cue to a significantly greater degree than either 13-14 year olds (p < .01), or 19-20 year olds (p < .01). The decreasing linear function for the .80-cue condition seems reasonable in light of the cue copying behavior of the youngest Ss and the performance of the adolescents and adults in the negative .80 condition. Since the 7-8 year old Ss tend to copy and use the cue to a greater extent than either of the other two groups, their cue utilization score will tend to be higher in both the positive- and negative-cue conditions. (Note a high positive cue utilization coefficient in the negative-cue conditions is related to poor achievement). The older Ss, on the other hand, were more accurate with their guesses since the closer the cue utilization coefficient is to zero the higher achievement will be. In fact, the obtained mean $Z'$ values for the 13-14 year olds (.125) and 19-20 year olds
(−.044) are not significantly different from zero (p < .001). These two phenomena have the effect of raising the cue utilization level of the youngest Ss and lowering it for the oldest Ss in the .80-cue condition. The intermediate position of the adolescents in the .80-cue condition is probably due to the fact that in the +.80-cue condition their cue utilization was significantly (p < .01) higher than that of the adults, and in the −.80-cue condition their cue utilization was significantly (p < .01) lower than that of the youngest Ss. When averaged across the positive- and negative-cue conditions, their cue utilization score is significantly higher than that of the adults and still significantly lower than that of the youngest Ss.

Demand characteristics of Ss may also account for the differences in performance between the adults and children. Based on comments made by many of the youngest Ss after they had completed the task, they viewed the task as a game to be played. They were told, in fact, that the task was a game. They seemed to enjoy the task, and whether they guessed a criterion value or not, it was still a fun game to them. A few of the children even expressed an interest in returning the next day to play the game again. It would seem, therefore, that these Ss felt no pressure or demand to succeed and, as a consequence, their positive cue strategy augmented their performance in the positive-cue conditions, while hindering their performance in negative-cue conditions. Some of the older Ss, on the other hand, expressed a degree of frustration at the completion of
the task. They appeared to enjoy the task during the early trials, but tended to become frustrated as the "correct" strategy for guessing the criterion values eluded them. Apparently they felt that since they were older, and supposedly more clever than children, they should be able to determine the "correct" strategy. As a result of their persistence in adopting complex hypotheses, the older Ss were not able to reach a very high level of performance in the positive-cue conditions, while at the same time, their willingness to experiment enabled them to come closer to solving the problem when given a negative cue. The net effect of the demand characteristics of the younger and older Ss was to produce a differential effect depending upon whether the Ss were performing in a positive- or negative-cue condition.

Unlike several other studies cited above, the present investigation found no significant cue magnitude effect. The absence of such an effect is difficult to explain. One major difference between this study and others was the presence of a negative ecological validity condition. Hence, it was expected that cue utilization coefficients would get more positive as the ecological validity coefficients increased in the positive-cue condition. Conversely, cue utilization coefficients would get more negative as the ecological validity coefficients increased in the negative-cue condition. Such a circumstance would be reflected in the direction x magnitude interaction of the analysis of variance. In the cue utilization analysis there
was an increase in utilization as ecological validity increased in both the negative- and positive-cue conditions. Utilization should have decreased in the negative-cue condition and the totally unexpected finding of it increasing is probably responsible for the lack of a significant magnitude effect as reported in other studies. Just why Ss' utilization of the negative cue was opposite in direction to what should be predicted is unexplained.

In summary, it is clear that Ss have much more difficulty dealing with environmental cues which are not positively related to the ecology. Subjects would seem to approach probability learning tasks with a mental set for positive relationships. There is some evidence that children tend to copy the cue more often than adults, and that while such a strategy will result in high achievement in a positive-cue condition, in a negative-cue condition, it is detrimental to their performance.
References


Appendix A
Instructions

You are going to take part in a learning experiment (game) today. You will find that the task (game) is very difficult, but I hope it will be interesting (fun).

You will see a number and a red question mark through the large window on the machine (E points). All of the numbers you will see will be between 10 and 99, and you can answer only with numbers between 10 and 99.

Listen carefully now. The object of the task (game) is for you to think of a number that corresponds to (goes with) the number shown in the window. I want to know what your best guess is. That is what the whole experiment (game) is about. You're guessing what number corresponds (goes with) the number in the window.

Before we actually begin the experiment (game), you will have five practice problems. To operate the machine and see the first problem, push the Red button marked A. Press the Red button. You can now see a number and a red question mark in the window. Now press the Red button again and we will find what number corresponds to (goes with) the first number. The Red number is the correct answer. For this problem ____ corresponds to (goes with) ____. This is the object of the task (game); to guess what number between 10 and 99 corresponds to (goes with) the first number you see. Now try again. Press the Red button to see the next problem. What number corresponds...
to (goes with) ____? Make a guess and write it here (5 points) with the pen. After you have written your answer down, press the Red button to see how close your answer is to the correct one. This is a very difficult task (game). You shouldn't expect to guess the correct answer more than once or twice, but try to guess as close to it as you can. Now there are three more problems that you can practice with. Press the Red button to bring the next problem up, and continue on until you come to a blank page. Stop there.

Now I'm going to review the instructions. Press the Red button marked A to see the number, then guess what number corresponds to (goes with) it. You can guess only with numbers between 10 and 99. After you have written down your guess, press the Red button again to see the correct answer. Compare your answer with the correct one, then press the Red button and go on to the next problem. There will be 100 trials (problems). After the first 50 there will be a blank space where you can take a rest or go right on. If the machine should skip a problem, or if you have any questions, please raise your hand. You may start now.

*All Ss were given these instructions except for slight modifications for the 7-8 year olds. They were read the phrases in parentheses to clarify the instructions.