Annotated Bibliography of Cue Probability Learning Studies

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Introduction

Cue probability learning involves an organism attempting to achieve (learn) a relationship with some distal criterion variable by attending to one or more multiple fallible indicators (differentially valid cues). Smedslund (1955) conducted the first multiple and single cue probability learning study after Brunswik (Brunswik & Herma, 1951), but it was Hammond and his students in the United States (Hammond, Hursch, & Todd, 1964; Hursch, Hammond, & Hursch, 1964), and Björkman (1965) and his student Brehmer (1972) in Sweden who initiated extensive programs of research. During a typical cue probability learning experiment a person makes judgments based on some number of probabilistic cues over a series of trials. The object is to correctly predict the quantitative or categorical criterion value on each trial. Cues differ in terms of their relevance (ecological validity) to the criterion. Trial by trial (outcome) feedback may be given on each trial, and/or cognitive feedback may be given after subsets of trials. Cognitive feedback concerns characteristics of the person's cognitive processes as well as characteristics of the task ecology.

In conjunction with preparation of The Essential Brunswik: Beginnings, Explications, Applications by Kenneth R. Hammond and Thomas R. Stewart (Eds.) for Oxford University Press (2000), Ken Hammond asked that an annotated bibliography of all published cue probability learning studies be prepared. A search of multiple and single cue probability learning publications using the Bibliographic Information System at the University of Colorado Center for Research on Judgment and Policy, and WinSPIRS (PsycINFO), produced a list of 315 references. The following annotated bibliography includes those journal articles, book chapters, doctoral dissertations, and technical reports. Doctoral dissertations that were later published in scientific journals are listed only with their journal references. Since the focus of this effort was on the learning process, studies concerned primarily with interpersonal cognitive conflict, but employed cue probability learning as a training methodology, are not included here.

Annotated Bibliography of Cue Probability Learning Studies

1951

Brunswik, E., & Herma, H. (1951). Probability learning of perceptual cues in the establishment of a weight illusion. Journal of Experimental Psychology, 41, 281-290.
Demonstrating use of representative design in a laboratory experiment on perceptual learning, Brunswik and Herma showed how a "weight expectancy illusion" could be created in a person by artificially establishing an ecological association between presentation position (right- vs. left-hand) and actual weight of an object. They artificially established ecological associations of 2 to 1 and of 4 to 1 between position (right- vs. left-hand presentation) as a perceptual cue, and weight as the referent variable were found to be effective in inducing an illusion of weight contrast. The probability learning curve, after first rising rather rapidly, showed a subsequent slow but steady decline to a compromise position. Under the conditions of the experiment, perceptual probability learning seemed not only not to be based on, but ran counter to, what was being learned at the conscious level.

1955

Smedslund, J. (1955). Multiple-probability learning: An inquiry into the origins of perception. Oslo, Norway: Oslo University Press.
Perceptions are assumed to be established by a process of multiple-probability learning; i.e., by a process of learning to utilize complex configurations of ambiguous or probabilistic cues. Two experiments were described. The first was an attempt to study the process of multiple-probability learning. The subjects were college students. The second explored the possibility of utilizing some probability-learning procedure as a diagnostic tool in clinical psychology. The subjects were 13-and 14-year-old children. It was concluded that the existence of multiple-probability learning was demonstrated, that the learning process was slow and inefficient, and that there were large individual differences in the speed and amount of learning.

1962

Summers, S. A. (1962). The learning of responses to multiple weighted cues. Journal of Experimental Psychology, 64(1), 29-34.
Ninth grade students were used to investigate the relation between the objective validity of certain cues and the extent to which these cues were used. The purpose was to analyze the learning of responses to multiple cues of different validities to determine how much the responses came to depend on each cue. The independent variable was the correlation between a criterion and each of three simultaneously presented visual cues. The dependent variable was the correlation between the cues and subjects' responses. Successful cue utilization increased during the learning session. Subjects' responded to different cues simultaneously, and the extent to which cues were used differed with validity. Throughout, cue utilization was proportional to cue validity.

1963

Carroll, J. D. (1963). Functional learning: The learning of continuous functional mappings relating stimulus and response continua. (Vol. (RB-63-26)). Princeton, NJ: Educational Testing Service.

A general model was proposed in which it was assumed that, in learning situations involving scaled stimuli and responses, subjects will tend to establish continuous functional relations between stimuli and responses. In particular, it was assumed that each subject has available a general "functional form" dependent only on certain parameters (pi), and that in learning the subject effectively assigns specific values to these parameters, thus establishing a specific function defining a unique mapping of stimuli into responses. In the specialized case of the model, the more restrictive assumption is made that the general form is constituted of linear combinations of more basic functions, so that the parameters (pi may be identified with the weights assigned to each of these primitive functions in establishing a particular stimulus-response mapping. This specialized model was assumed throughout the present study. Three hypotheses were derived from the postulates of the proposed model, and an experimental study was undertaken designed to test these hypotheses, as well as to answer a number of related questions. The hypotheses were: (I) Subjects will reproduce responses which bear a continuous relation to stimuli (according to an index proposed as an operational measure of continuity) even when the stimulus-response pairs they are given to learn are randomly related. (II) A set of stimulus-response connections related by a continuous function will be learned more efficiently than a randomly related set. A secondary hypothesis was that "simple" functional relations (defined by few parameters) will be learned more effectively than more "complex" functions (defined by a greater number of parameters). (III) Subjects will respond to stimuli to which no response has been explicitly associated in learning by interpolating or extrapolating the functional relation to these stimuli. The experimental paradigm used consisted of a paired associates task involving 26 scaled stimuli ("V" marks varying along the length of a narrow rectangle), only 15 of which were used in the learning phase of each trial, the remaining 11 being included in the reproduction phase to allow observation of interpolation and extrapolation effects. Six conditions were used, in three of which the response (a vertical mark on a line below the rectangular slot) was related to the stimulus according to a simple continuous function (linear in two cases, quadratic in the third), while in the other three conditions stimuli and responses were randomly related. All three hypotheses outlined above were verified. In addition, an analytic technique utilizing Fisher's method of orthogonal polynomials was applied, enabling determination of which polynomials significantly related to mean responses (averaged over six trials), and of which polynomials exhibited significant trial to trial variation in slope. It was found that the first four orthogonal polynomials were sufficient to account for most of the reliable variance in mean responses. Trial to trial variance was slight, but significantly present, while tending to be somewhat more heavily concentrated in the higher degree polynomials. The residual variance in the means, once significantly fitting polynomials were extracted, was generally non-significant, and no evidence was found that the residuals tended to represent discrete "correction" toward the veridical S-R pairings. The data were subjected to an Eckart-Young analysis with a rotation aimed at finding continuous structure. Three factors were found, very nearly identical with the first three orthogonal polynomials, but bearing a slightly closer resemblance to sinusoidal curves of varying frequency. These accounted for about 88% of the variance in the mean responses, a fact taken as supporting the adequacy of the

"specialized" model.

Uhl, C. N. (1963). Learning of interval concepts: I. Effects of differences in stimulus weights. Journal of Experimental Psychology, 66(3), 264-273.
A type of learning task was studied in which a multiple-regression prediction equation defined the relationship between three stimuli and a criterion which the subject's response attempted to predict. seven tasks, each having a stimuli-criterion multiple R of unity, differed in the degree of disparity in the distribution of regression weights to stimuli from one extreme where all stimuli had equal weights to the opposite extreme where only one stimulus was weighted. In an eighth task none of the stimuli were weighted. Eighty undergraduate subjects, 10 per task, were given 150 training trials. The functional relationship between performance and disparity of weights was nonmonotonic. Performance was poorest in tasks with small disparity of weights, slightly better with no disparity of weights, and markedly better with larger disparity of weights. (18 ref.)

1964

Hammond, K. R., Hursch, C. J., & Todd, F. J. (1964). Analyzing the components of clinical inference. Psychological Review, 71(6), 438-456.
This paper analyzes the components of clinical inference within the framework of Brunswik's lens model by means of multiple regression analysis. Two parallel studies of clinical psychologists, the performance of subjects in a quasi-clinical task, and the performance of subjects learning a multiple-cue probability task involving neutral stimuli provide the context for the analysis. Special reference is made to the problem of clinical vs. statistical prediction. Implications for the interrelation between experimental psychology, cognitive theory, and clinical tests are discussed.

Hursch, C. J., Hammond, K. R., & Hursch, J. L. (1964). Some methodological considerations in multiple-cue probability studies. Psychological Review, 71(1), 42-60.
The authors' principal concern is to make plain that in multiple-cue probability studies carried out within the framework of multiple regression analysis, the statistical properties of the environment and the statistical properties of the response process affect the results. Such statistical properties must be considered when planning multiple-cue probability studies or interpreting their results. Formuli are provided specifying the limitations placed on achievement (inferential accuracy) by statistical factors in certain environments which may be arranged by an experimenter. Illustrations of the application of the analysis from the two most representative cases are provided: one for probability learning, and one for clinical inference. (27 ref.)

Peterson, C., & Ulehla, Z. J. (1964). Uncertainty, inference difficulty, and probability learning. Journal of Experimental Psychology, 67(6), 523-530.
On the basis of information provided by a cue, subjects inferred which of a set of criteria would occur. two different problems were studied using this experimental task. Problem I evaluated the effects of four different information-theory variables upon five different measures of inference difficulty. Difficulty of inference increased with increased uncertainty of the criteria not resolved by the occurrence of the cue. Problem II studied the relations between three different conditional probabilities associated with the most frequently occurring criterion. Response probability approximated or exceeded the corresponding probability of occurrence, which in turn exceeded the corresponding subjective probability.

1965

Björkman, M. (1965). Learning of linear functions: Comparison between a positive and a negative slope. University of Stockholm, Psychological Laboratories (Report 183).
The hypothesis that a linear function with a positive slope will be learned more effectively than one with a negative slope was tested in an experiment with twelve year-old subjects. The experiment was performed by a paper and pencil test, where the stimuli and their assigned responses were lines varying in length. The group which trained on the positive relation showed significantly more effective learning. This group was also superior when tested on interpolated and extrapolated stimuli not used during training. The conclusion can be drawn that a positive correlation between quantitative stimuli is more accessible than a negative one.

Björkman, M. (1965). Studies in predictive behavior: Explorations into predictive judgments based on functional learning and defined by estimation, categorization, and choice. Scandinavian Journal of Psychology, 6(3), 129-156.
A model for functional learning with a subjective regression which intervenes between stimuli and predictive responses was used. Subjects had to predict motion time of a ball rolling down a chute. The estimation experiments showed that (1) the relation between predicted and objective time is biased in the direction of T predicted = T squared, (2) training does not increase the veridicality. In the categorization experiments (1) learning occurred more rapidly with homogeneous categories, (2) transfer was facilitated after training on heterogeneous categories, (3) learning occurred without reinforcement by observation. In a choice experiment two simultaneous processes were studied, functional and probability learning. (24 ref.)

Hammond, K. R., & Summers, D. A. (1965). Cognitive dependence on linear and non-linear cues. Psychological Review, 72, 215-224.
Analysis of the cognitive process of inductive inference should focus on inferences drawn from nonlinear as well as linear relations. Analysis of subjects' utilization of nonlinear relations is illustrated by studying 30 subjects in the following task: (a) one cue related in a linear, the other in a nonlinear manner to a criterion; (b) the criterion partly, but not perfectly, predictable from either cue alone; and (c) the criterion perfectly predictable from appropriate utilization of both. Results indicate that subjects can improve both overall performance and nonlinear data utilization, and that performance varied with task-relevant instructions. (27 ref.)

Newton, J. R. (1965). Judgment and feedback in a quasi-clinical situation. Journal of Personality and Social Psychology, 1, 336-342.
Subjects predicted school grade point averages from four cues with no outcome feedback. Feedback for the five other conditions consisted of the achievement index plus varying amounts of lens model feedback (ecological validities and/or cue utilization coefficients). The three feedback conditions containing ecological validities led to significantly improved predictive accuracy (achievement, ra).

Peterson, C. R., Hammond, K. R., & Summers, D. A. (1965). Multiple probability-learning with shifting weights of cues. American Journal of Psychology, 78, 660-663.
The purpose of this experiment was to study the way in which weights of cues for responses shift as a result of chance in objective weights of the cues. In a multiple-cue probability learning task, 29 nurses each observed 200 stimulus arrays (trials) showing three cues. Predictions of the criterion value were made on each trial, and each prediction was followed

immediately by outcome feedback. Weights of the three cues on the first 100 trials (2/3, 1/3, 0) shifted to 0, 1/3, and 2/3 on the second 100 trials. Response-cue weights rank-ordered appropriately during the first 20 trials, and remained so during the first 100 trials. Following the shift in weights of the cues. response-cue weights also shifted, but did not achieve appropriate rank ordering until the third block of 20 trials.

Peterson, C. R., Hammond, K. R., & Summers, D. A. (1965). Optimal responding in multiple-cue probability learning. Journal of Experimental Psychology, 70(3), 270-276.
Fifty-seven subjects participated in a 3-cue, probability-learning experiment for 200 trials. The response system of subjects was compared with the optimal response system as defined by a linear multiple-regression equation. Results indicated that subjects fell only a little short of the optimal response strategy. The response-criterion correlation of about .73 corresponded to an optimal value of .83. Both (a) the response multiple R of about .90 and (b) the response-optimal response correlation of about .85 corresponded with optimal values of 1.0. Response-cue weightings of about .41, .33, and .21 corresponded with optimal values of .50, .33, and .17. Confidence intervals (95%) of the response-cue weightings remained appropriately separated after the first 40 trials.

Peterson, C. R., & Ulehla, Z. J. (1965). Sequential patterns and maximizing. Journal of Experimental Psychology, 69, 1-4.
Most subjects in probability-learning experiments do not maximize, perhaps because they expect sequential patterns. The purpose of this experiment was to determine whether or not the elimination of the objective tenability of sequential dependencies would increase the proportion of maximizing responses. Twenty-one subjects in the experimental condition controlled the random generation of events by throwing a die so that sequential dependencies were objectively unreasonable. Twenty-one control subjects were presented prearranged sequences, making it reasonable for subjects to anticipate sequential patterns. Results confirmed the experimental hypothesis; experimental conditions led to more maximizing responses than did control conditions at the .01 level of significance.

Todd, F. J., & Hammond, K. R. (1965). Differential feedback in two multiple-cue probability learning tasks. Behavioral Science, 10(4), 429-435.
Seventy-two University of Colorado undergraduates were given the task of observing three cues (size of circle, position of a chord in the circle, and position of a pointer on the periphery of the circle) appearing on cards, and, on the basis of the three cues, of estimating the value of the criterion, a number appearing on the back of the card. Three feedback groups were defined: outcome feedback, lens model feedback, and mixed feedback. The primary finding is that in multiple-cue probability tasks, information which allows the subject to compare his dependency on cues with their ecological validities is of greater value than knowledge of how well his responses correspond trial by trial to the criterion values. Furthermore, the addition of the latter to the former provides no greater success than does lens model feedback alone.

1966

Azuma, H., & Cronbach, L. J. (1966). Cue-response correlations in the attainment of a scalar concept. American Journal of Psychology, 79, 38-49.
The present study examines how subjects use multiple cues in solving a scaled concept problem. The desired response to each stimulus corresponds to a weighted sum of certain

cue-variables. Subjects were required on each trial to estimate the scale-value assigned to the stimulus by the (unknown) rule; they were then told the correct value. It is reported that subjects do not solve a single problem even though B regards the universe as an undifferentiated whole. Subjects isolate sub-universes and find a suitable response for one sub-problem separate from another. The authors do not disagree with the suggestion that learning be viewed as the establishment of cue-response correlations, but such correlations can describe a subject's solution only if they are calculated separately for the sub-universes for which a subject has developed separate rules. Concept formation with stimuli such as in the present study seems to consist of two processes that move forward simultaneously: isolation of sub-universes and identification of a rule applying within the sub-universe. At a later stage, perhaps a subject does merge the sub-universes and apply a single parsimonious rule. It is concluded that a more powerful method of analysis than the calculation of cue-response correlations is required to describe the operations a subject uses at any point in training. Over-all cue-response correlations calculated from training trials are at best a first approximation to the process by which a concept is attained.

Azuma, H., & Ochiai, T. (1966). The structure of cue-criterion relationship and the detectability of a cue. Japanese Psychological Research, 8(2), 90-98.
Differentiates two types of cue-criterion relationships: (1) the probabilistic structure in which the cue hits the criterion value at a given percentage, and (2) the covarying structure in which the cue values have significant regression upon the criterion value. These two structures were compared with regard to the detectability of cues in a task of detecting and utilizing the relevant cue, the payoff for correct utilization being controlled. Subjects were female college students. The probabilistic cue was clearly easier to detect, and the covarying cue was practically unrecognizable when the effect of higher percentage of hit was partialed out. Some of possible limitations, hypotheses, and implications are discussed.

Björkman, M. (1966). Predictive behavior: Some aspects based on an ecological orientation. Scandinavian Journal of Psychology, 7, 43-57.
Ecological 'dimensions' along which psychologists choose their experimental environments are surveyed in terms of the following characteristics: nominal-quantitative stimuli, determinism-probabilism, number of stimuli per event, event and causality, repetition of stimuli. A distal distinction between predictive and descriptive responses is suggested and perceptual learning is discussed with this classification as background. It is argued that cognitive mapping of ecological relationships is an indispensable mediator as far as predictive behavior is concerned. The dependence of experimental learning on ecological properties of the learning material is stressed.

Dudycha, L. W., & Naylor, J. C. (1966). Characteristics of the human inference process in complex choice behavior situations. Organizational Behavior and Human Decision Processes, 1(1), 110-128.
10 subjects were assigned to each of six experimental 2-cue inference conditions created by varying the validity of the first cue across levels of .40 and .80, and by varying the validity of the second cue across levels of .20, .40, and .60. In each case the two cues were orthogonal. All performance indices closely approximated the dictates of a probability matching strategy. Subject consistency did not deviate greatly from the predictability available in the stimulus system, and subjects exhibited a high degree of ability in matching their equations to those defining the environmental complex. The value of a second ecological cue was a function of both the validity of the cue itself and the validity of the cue it was paired with. Pairing an

additional cue to one of low validity was always facilitating, while adding an additional cue to one of high validity was always detrimental. (18 ref.)

Hammond, K. R., Wilkins, M. M., & Todd, F. J. (1966). A research paradigm for the study of interpersonal learning. Psychological Bulletin, 65(4), 221-232.
A research paradigm is introduced to investigate the process whereby one person learns to predict the behavior of another person. The paradigm is derived from Brunswik's probabilistic functionalism and his lens model of behavior. Methods of analysis are applied to data provided by an illustrative experiment. Results of the experiment show that interpersonal learning occurs. Results are also shown to have implications for problems inherited from studies of interpersonal perception.

Summers, D. A., & Hammond, K. R. (1966). Inference behavior in multiple-cue tasks involving both linear and nonlinear relations. Journal of Experimental Psychology, 71(5), 751-757.
90 subjects made predictions in 2-cue tasks having the following characteristics: (1) one cue related in a linear manner, the other in a nonlinear manner to the criterion, (2) the criterion partly, but not perfectly, predictable from either cue alone, and (3) the criterion perfectly predictable from both cues. Subjects were studied under three conditions involving different proportions of linear and nonlinear task variance, and three levels of task information. Results indicate that task properties and task information determine both inferential accuracy and cue dependence.

Uhl, C. N. (1966). Effects of multiple stimulus validity and criterion dispersion on learning of interval concepts. Journal of Experimental Psychology, 72(4), 519-527.
The basic interval-concept-learning task employed three stimuli with relative validities of .775, -.225, and .00. A 4 X 3 factorial design was used incorporating squared multiple correlations (R squared) of 1, .67, .33, and 0 between the stimuli and the criterion, and criterion standard deviations (criterion dispersion, CD) of 3, 5, and 7. Subjects were given 360 training trials. Learning performance was a positive linear function of R squared as measured by: response validity, error scores, stimulus dependency, and cue utilizations. The only effect of CD was to facilitate utilization of the stimulus whose relative validity was -.225 when R squared = 1. Response standard deviation was reduced with smaller values of both R squared and CD, although there was a general tendency for subjects to disperse their responses too widely for maximum accuracy. It was concluded that interval concept learning is seriously impeded when R squared < 1.

1967

Björkman, M. (1967). Stimulus-event learning and event learning as concurrent processes. Organizational Behavior and Human Performance, 2, 219-236.
A modified version of Brunswik's lens model was applied to the analysis of event learning and stimulus-event learning as concurrent processes in the nonmetric case. It is shown that functional validity, defined as a matrix containing the joint occurrence of responses and events, is the product of the ecological and the utilization matrices. The case of a 2-choice situation is examined and achievement for various types of performance is studied. A method for quantitative separation of the two processes is presented. (22 ref.)

Summers, D. A. (1967). Rule versus cue learning in multiple probability tasks. Proceedings of the Annual Convention of the American Psychological Association, 2, 43-44.

1968

Björkman, M. (1968). The effect of training and number of stimuli on the response variance in correlation learning (Umea Psychological Reports No. 2): Sweden: University of Umea, Department of Psychology.
A correlation task was constructed by using the numbers 1, 2, 3, 4 and 5 as a cue-variable and lines of varying length as criteria. Three experiments were designed on the assumption that correlation learning involves functional learning and probability learning and that the subjects first learn the functions As a consequence the response variance should decrease by training, which is demonstrated in Experiment I for various forms of the criterion distribution. A second consequence is that the response variance will be relatively larger when the correlation between cue and criterion is lowered. This hypothesis gets support from Experiment II. The third experiment is a corollary showing that no change of the response variance occurs when the correlation is zero and the material is reduced by decreasing the number of stimuli.

Howell, W. C., & Emanuel, J. T. (1968). Information feedback, instructions and incentives in the guidance of human choice behavior. Journal of Experimental Psychology, 78(3), 410-416.
Two experiments (Ns = 64 and 40 paid undergraduates) explored the influence of information feedback (IF) on choice behavior in a task requiring discrimination between two populations of meter readings. Sample information was provided through stimuli and IF, with the major objective being to determine the relative efficacy of the sources in guiding behavior under a variety of pertinent task conditions (%IF, specificity of instructional set, monetary payoff). Results supported the conclusion that IF is the only source of information made use of consistently in this situation; stimulus information seemed only to inhibit discrimination. (16 ref.) ((c) 1997 APA/PsycINFO, all rights reserved)

Naylor, J. C., & Clark, R. D. (1968). Intuitive inference strategies in interval learning tasks as a function of validity magnitude and sign. Organizational Behavior and Human Decision Processes, 3(4), 378-399.
Nine groups of 10 undergraduates each performed for 200 trials on interval learning tasks in which the stimulus, response, and reinforcement continua were continuous scaled variables. The nine experimental conditions were defined by the size and sign of the r between the stimulus and reinforcement (criterion) distributions, i.e., re ranged from -.80-+.80 in steps of .20. There was little or no evidence for matching behavior with correlational performance measures. Subjects learning positive re relationships tended to overmatch (rs > re), with the tendency to do so increasing as the size of re decreased. Subjects who learned negative re values consistently undermatched (rs < re), apparently due to a general set to regard "relatedness" as a positive phenomenon. Analysis of subjects' conditional response arrays showed that subjects' conditional response distributions had greater dispersion than the corresponding conditional reinforcement distributions. The size of this effect increased as a function of the absolute magnitude of re and was most evident with high and low stimulus arrays. A tendency for subjects to displace the array means followed a similar pattern. (22 ref.)

Naylor, J. C., & Schenck, E. A. (1968). The influence of cue redundancy upon the human inference process for tasks of varying degrees of predictability. Organizational Behavior and Human Decision Processes, 3(1), 47-61.

Nine groups of 10 undergraduates each performed in a 200 trial typical multiple-cue learning situation. The groups were defined in terms of three levels of cue redundancy between the two cues (rij = .0, .4, .8) and 3 levels of total system predictability (re = .5, .7, .9). While both absolute and relative achievement were found to be significantly and directly related to rij and re, the effects of rij were greater at high re levels. This interaction was attributed primarily to subjects' increasing inability to match the total ecology at low re levels as cue redundancy increased. Subject consistency also varied directly with rij and re, while subjects' ability to develop proportional strategies varied only as a function of rij. The obtained importance of cue redundancy as a variable in multiple-cue inference tasks thus strongly supports Brunswik's argument for "representativeness" in probabilistic inference research. (18 ref.)

Summers, S. A. (1968). Alternative bases for choice in probabilistic discrimination. Journal of Experimental Psychology, 76(4, PT. 1), 538-543.
A probability learning task provided 50 subjects with two bases for prediction: what was usual in relation to particular cues and what was usual overall, across cues. Subjects could predict outcomes from pi, the overall probability, or from pi and pi, probabilities under each cue, pi > pi, and pi = 1 - pi. Ten subjects were assigned to each of four conditions, with pi values of .6, .7, .8, and .9, and to a control condition with pi of .5. Means of the overall response probabilities closely matched the pi's, but responses to cues went beyond pi and pi in the direction of maximization. The mean number of correct responses differed among conditions but approached the number that could be achieved by maximizing to the cues. The influence of the cues may have resulted partly from contrast between their indications and the overall pattern.

1969

Björkman, M. (1969). Individual performances in a single-cue probability learning task. Scandinavian Journal of Psychology, 10(2), 113-123.
Studied inference behavior in a 2 x 2 cue-criterion task. Forty undergraduates and 10 law students were distributed on five conditions varying in cue validity and base rate. Subjects were studied individually with respect to four cognitive strategies: matching, maximizing, double matching, and differential maximizing. The utilization coefficients of the average subjects tended to "overshoot" when the cue validity was high and to "undershoot" when the validity was low. Double matching and differential maximizing were the most common strategies. Cognitive activity was interpreted as a compromise between various type performances.

Brehmer, B. (1969). Cognitive dependence on additive and configural cue-criterion relations. American Journal of Psychology, 82(4), 490-503.
Hypothesized that the characteristics of the human cognitive process are dependent on the characteristics of the cognitive task. The finding that humans use information only in a linear, additive way is due to the fact that linear, additive tasks have been used rather than to the characteristics of the human inference process. A learning experiment comparing the learning of linear, additive cue-criterion relations with that of configural relations showed that 40 undergraduates were able to learn configural relations when there were such relations in the task, giving support to the hypothesis.

Eimas, P. D. (1969). Multiple-cue discrimination learning in children. Psychological Record, 19(3), 417-424.

Trained 270 kindergarten, 2nd and 4th grade children on a simultaneous discrimination with either 2, 3, or 4 relevant and redundant visual cues. Test trials were given which measure the acquisition of choice responses to each of the relevant cues separately. Students, with the exception of one training condition, learned something about two, often three, and in some individual cases four cues, the number increasing with CA and MA. With an increase in the number of relevant cues, the amount learned about any one cue deceased and the number of cues about which something was learned was reduced for kindergarten and 2nd grade students. Results are discussed in terms of a limited capacity to utilize redundant information, which increases with developmental level.

Gillis, J. S. (1969). Schizophrenic thinking in a probabilistic situation. Psychological Record, 19(2), 211-224.

Demonstrates the utilization of a new technique for the study of schizophrenic thinking. 48 hospitalized schizophrenics were confronted with tasks which required inferences to be made on the basis of cues having uncertain relationships with a criterion. The tasks varied according to the number of cues which must be effectively utilized and were presented by means of both impersonal and socially-relevant stimuli. Results indicate that schizophrenics function as well as normals on impersonal tasks which require limited cues. Their performance is increasingly impaired as more cues must be integrated, and their functioning on tasks with interpersonal relevance is uniformly inadequate. Normals function with equal adequacy on impersonal and socially-relevant tasks regardless of the range of cues which must be utilized. (33 ref.) ((c) 1997 APA/PsycINFO, all rights reserved)

Gillis, J. S., & Davis, K. E. (1969). The effects of amphetamine and chlorpromazine on complex thinking in paranoid and nonparanoid schizophrenics (Report 111). Boulder: University of Colorado, Center for Research on Judgment and Policy.

Himmelfarb, S. (1969). Combination of cues of varying validities in the perception of persons. Proceedings of the Annual Convention of the American Psychological Association, 4(Pt. 1), 405-406.

Conducted two experiments to determine how subjects weight information from cues varying in validities. Sixty-nine subjects learned the validities of sets of single cues. Several models of compounding behavior were examined. Results indicate that the best fit was provided by a weighted averaging model in which the weights varied as a function of the degree to which the cue led to a correct response during learning. The implications of these results for impression formation research are discussed. ((c) 1997 APA/PsycINFO, all rights reserved)

Schenck, E. A. (1969). A study of the independent effect of cue redundancy upon the human inference process in tasks of varying predictability. Dissertation Abstracts International, 29(9-B), 3516.

Earlier experimentation in multiple cue probability learning has shown that performance is directly related to the amount of cue redundancy present in a task. This relationship, however, was judged to be ambiguous due to algebraic dependencies among redundancy, task predictability, and the individual cue validities when employing the multiple regression model. The present experiment was designed to replicate part of this earlier experimentation and to include tasks which juxtaposed decreasing task predictability with increasing cue redundancy. The latter was done in order to provide a test of the independent contribution of cue redundancy to performance. Five groups of ten subjects each were trained for 120 trials in a two-cue task of high predictability (Re = .90) and zero redundancy (r = .00). Then for

another 120 trials, two of these groups continued to perform under higher redundancy conditions (.40 and .80) while task predictability was held constant. The other groups also continued to perform under similar chant in redundancy, but the cue validities were held constant and predictability was allowed to drop. The fifth group continued to perform under zero redundancy. These manipulations were employed for five other groups of ten subjects with the difference that task predictability was set at a lower level (Re = .70). Performance indices of achievement, consistency, and matching were analyzed. Attention was focused, however, upon consistency, the linear component of performance, since the subjects were virtually perfect strategy matchers. That is, it was concluded that, at least for tasks involving cues of equal validity, achievement may be closely approximated by the product of consistency and task predictability. The notion that cue redundancy affects subject consistency only in so far as it modifies the level of the cue validities or task predictability was clearly contradicted by the results. Consistency was found to be directly related to cue redundancy, but primarily in the tasks with high predictability. This relationship persisted, although with somewhat less strength, even when, task predictability was allowed to drop. Specific predictions of this increase in consistency were made by hypothesizing that individuals do not change the weights they give to cues under zero redundancy conditions as this redundancy is raised. These predictions were found to fall short of the obtained increase in consistency for tasks with high predictability. In the tasks with lower predictability, the success of the predictions was uncertain.

Summers, D. A. (1969). Adaptation to change in multiple probability tasks. American Journal of Psychology, 82(2), 235-240.
Examines effects of cue, rule, and complete shifts upon performance in a 3-cue, probability-learning task. One hundred and twenty undergraduates served as subjects. Results indicated that both the initial performance decrement and the rate of improvement after the shift were affected by which aspects of the task undergo change.

Summers, S. A., Summers, R. C., & Karkau, V. T. (1969). Judgment based on different functional relationships between interacting cues and a criterion. American Journal of Psychology, 82, 203-211.
Varied the form of the function relating cue and criterion values. The cues were 2 stimulus dimensions on slides of simulated blood cells; the criterion was the age of the cells. Each subject in 4 groups of 16 undergraduates was presented with 1 particular relationship (linear, multiplicative, or exponential) and attempted to predict the criterion values from the cues. The Subjects learned over the 640 trials to use the relationship to which they were exposed, as indicated by increased correlations between responses and criterion and by decreased differences of response from criterion values. The valid use of nonlinear components increased over trials and, in spite of an initial tendency to use a linear function, the subjects generally came to match their own function most closely.

1970

Brehmer, B. (1970). Inference behavior in a situation where the cues are not reliably perceived. Organizational Behavior and Human Decision Processes, 5(4), 330-347.
Required subjects to infer the meeting-point of two cars from their perception of the cars' velocities, to study the effects of the lack of reliability in perception of cue values on learning to make inferences. Results of four experiments with 74 undergraduates indicate that

subjects' performance can be predicted from psychophysical estimates of the validity of the information available to them and multiple-cue probability learning data. Thus, subjects cope with uncertainty, caused by lack of reliability in their perceptual system, in the same way that they cope with uncertainty in the physical cue-criterion relations. Results also show judgments of velocity and meeting-points to be poor under most conditions. ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B., & Lindberg, L. A. (1970). The relation between cue dependency and cue validity in single-cue probability learning with scaled cue and criterion variables. Organizational Behavior and Human Decision Processes, 5(6), 542-554.
Found that the relative consistency of the inference behavior of 54 undergraduates was the same for the 3 levels of cue validity .45, .70, and .90, but that subjects made more extreme inferences at lower levels of validity than at higher levels. This result indicates that the inverse relation between departure from matching and cue validity, usually found in single-cue probability learning experiments, can be explained in terms of extremeness of inferences. Since similar relations between extremeness and validity of information have been found in Bayesian studies of inference behavior, results also suggest that the correlational and Bayesian approaches may be more closely related than has, so far, been assumed. ((c) 1997 APA/PsycINFO, all rights reserved)

Cvetkovich, G. T. (1970). Judgment processes in small groups: A longitudinal study of learning, conflict and compromise. Dissertation Abstracts International, 30(12-B), 5708.
The present study is designed to investigate the activities leading to the achievement of the two major goals of a successful group: making a valid judgment and maintaining group harmony. Most prior research in this area has focused on such structural factors as size, heterogeneity or communication influencing group performances. In essence, these studies have been attempts to manipulate aspects of group organization and observe the resulting effects on group performance. Within the laboratory, scant empirical attention has been given to those factors determining group organization. Most important in this respect is the nature of the task facing the group. Experimental study of the effects of task, however, has been hindered because previously used laboratory tasks have not been representative of tasks facing real-life groups. This is true in at least three major ways. Most tasks used: (a) are mechanistic and fully determined, (b) do not permit learning, and (c) require short periods of time for completion. By contrast, real-life groups usually: (a) work on problems involving a high degree of uncertainty: (b) can improve judgments I)v observing the outcomes of their decisions, and (e) have spent an extended period of time working together as a group. The innovation of this work is that these activities are studied in laboratory groups working on a task which captures the three above outlined characteristics of non-laboratory tasks.
Design. Five person groups composed of male college students made judgments about an uncertain multiple-cue task for approximately one hour on each of eight successive days. The task required individual and group judgments of how long survivors of a nuclear attack should remain sheltered. After each trial, information regarding accuracy of judgment is provided. Groups made judgments under one of four payoff structures: (a) No Pay (Subjects receiving only a daily wage for participation); (b) High Pay for accuracy of joint judgment-low pay for individual domination of joint judgment (High Accuracy); (c) Low pay for joint accuracy-high pay for individual domination (High Dominance), and (d) Equal pay for both joint accuracy and domination (Equal).
Results. Results are organized into three areas: (1) Conflict: Groups working under different

pay structures differ in amount of intragroup cognitive conflict (measured by discrepancy in thinking between group members). The No Pay group is highest in overall conflict, while the Equal Pay group is lowest in conflict. High Accuracy and High Dominance groups are similar and intermediate to the extremes of Equal and No Pay groups. (2) Learning: All groups, regardless of specific pay structure, are equal in ability to make correct judgments about the uncertain task. This is true in terms of both accuracy of joint judgments and accuracy of individual judgments of group members. (3) Group Processes: In addition to effects on conflict, reward structure has a large effect on the character of the group. The reward structure seems to determine the particular internal problems which the group must resolve. This is seen most clearly in terms of affective relations between group members. Subjects paid substantial amounts for domination (High Dominance and Equal groups) like their own group partners less than do members of the other groups.
Conclusion. On the methodological level present findings indicate the advantages of including representative considerations in the design of experiments studying social behavior. Through such an approach both affective and cognitive behavior can be studied within the same analytical framework. Theoretically, the present findings indicate that the role formally assigned to competition as a major detriment to group maintenance has been overemphasized. Competition has a direct causal effect on the group only when other representative factors such as learning are excluded from the situation.

Deane, D. (1970). Feedforward and multiple-cue probability learning. Institute of Behavioral Science, Cognitive Processes Program, Report 131.

Earle, T. C. (1970). Task learning, interpersonal learning and cognitive complexity. Oregon Research Inst., Eugene.; Colorado Univ., Boulder. Inst. of Behavioral Science., ORIR-Bull-Vol-10-No-2.
The study of human learning has neglected interpersonal learning, mainly because of its complexity. However, with the recent development of a new methodology and research paradigm, empirical studies have been initiated. This is a report on one such study, involving 40 male University of Oregon students divided into two groups of 10 pairs of subjects. The task learning (TL) group and the interpersonal learning (IPL) group were trained for 60 trials to predict a numerical criterion on the basis of two numerical cues (X1 and X2). For the TL group, pairs of subjects were trained to use the same cue according to the same rule. For half the pairs, X1 was linearly related to the criterion, while for the rest, X1 was a nonlinear cue. In the IPL group, each pair was differentially trained, with one using X1 as a linear cue, and the other using X2 as a nonlinear cue. When the pairs were combined for a task involving two equally valid linear and nonlinear cues, the IPL group adapted significantly better to the task due to the linear subjects' inability to learn to use the nonlinear cue on the basis of task learning alone.

Eisler, H., & Spolander, K. (1970). On the sign of slope in the learning of linear functions. Scandinavian Journal of Psychology, 11(3), 176-184.
Presented 21 sixth graders in three equal groups with pairs of values (E and S) of three different linear functions $E = a + bS$. In a test phase subjects indicated the E values that corresponded to the S values. Values were represented as distances marked on straight lines. two groups, one a control group, had a positive slope, and the third group a negative. The squared sum of the S-E differences was kept constant. All groups had roughly the same performance as measured by the squared sum of deviations from empirical and correct E

values. The learning curves, however, indicate that some learning had taken place in the group with the negative slope. It is concluded that a principle rather than a function was learned.

Himmelfarb, S. (1970). Effects of cue validity differences in weighting information. Journal of Mathematical Psychology, 7(3), 531-539.

Two experiments were conducted to determine how cues varying in validity are combined in categorizing a person. Subjects learned the validities of single facial cues and then responded to compounds of the cues. There were 24 undergraduate subjects in Experiment I, and 45 in Experiment II. Three special cases of a generalized weighted averaging model for combinatorial behavior were examined: a simple averaging model, a cue weighting model, and a complete discounting model. The best fit was provided by the cue weighting model, but the discrepancies from the model indicate that it was not giving sufficient weight to the most valid cue. No evidence for a summation process was obtained in cases of nonconflicting cue compounds.

Miller, M. J., & Sarafino, E. (1970). The effects of intercorrelated cues on multiple probability learning (Rep. No. 128): Boulder: University of Colorado, Institute of Cognitive Science.

The effect of partial redundancy in 5-cue probability learning tasks was evaluated in terms of subjects' achievement, response consistency, and cue-utilization. Two groups of subjects were given different 5-cue probabilistic tasks which had similar cue-criterion relations (r = .6, .5, .4, .3, and .2) and task predictability (R^2 = .98 and .96). In one condition, no intercorrelations existed among the cues: in the other, only the three lowest validity cues were intercorrelated with each other, with r = .75. Higher achievement was observed under orthogonal conditions ($p < .01$) with some suggestion of lower response consistency under redundant conditions. A cue-matching strategy was apparently employed in both conditions, with subjects in the redundant condition overweighting low validity redundant cues. The results support the view that a cue-Matching strategy involves adjustment of response beta-coefficients to match cue-criterion correlations.

Summers, D. A., Taliaferro, J. D., & Fletcher, D. J. (1970). Judgment policy and interpersonal learning. Behavioral Science, 15(6), 514-521.

Ninety-six undergraduates predicted another person's judgments about the socioeconomic growth of a series of underdeveloped nations. Following each prediction, subjects were informed of the actual judgment made by the person (target) whose policy they were attempting to learn. Results from 150 learning trials revealed that interpersonal learning was significantly influenced by (a) the substantive differences among the judgment policies to be learned, and (b) the type of information initially available to the learner. Regarding the latter, it was found that subjects who were shown a quantitative description of the target's policy provided by a regression analysis learned to predict the target's judgments with substantial accuracy. In contrast, subjects who were initially shown policy descriptions (either quantitative or verbal) provided by the target himself performed significantly less well. (17 ref.)

Winters, E. P. (1970). Person perception in multiple-cue probability learning task as a function of cognitive complexity and inferential set. Dissertation Abstracts International, 30(12-B), 5681.

This study was conducted in order to investigate the relationship between cognitive complexity, one measure of cognitive differentiation, and the accuracy and process of

interpersonal learning and perception. Additionally, the effect of differing degrees of ego-involvement with the task was explored. Forty-eight female subjects, divided into high (complex) and low (simple) complexity groups on the basis of the Role Construct Repertory Test, rated the overall personal adjustment of 45 stimulus people under ego-involving and neutral inferential set conditions. Judgments were made both before and after training designed to improve discrimination. Brunswik's Lens Model of Inference was employed in analyzing the data, and the results clearly corroborated previous findings that an additive linear regression model accounts for the major portion of variance in subjects' response systems to a multiple cue task. Although the predicted inverse relationship between cognitive complexity and accuracy of judgment failed to attain statistically significant levels, in all cases the post-learning group means were in the expected direction, with complex subjects being more accurate, more linear, and utilizing cues to better advantage than simple subjects. A similar situation was found for the ego-involved subjects, as opposed to those in the neutral set condition. The results also offered tentative evidence for a complexity difference in process of judgment which leads to differential improvement in the task. Serendipitously, it was observed that a stereotypic judgment process based on overly-relevant cue dimensions biased the pre-learning trials by permitting excessively high achievement in the operant state.

1971

Bauer, M. (1971). Effects of absolute and conditional probability judgments on prediction in probabilistic inference (Umea Psychological Reports No. 52): Sweden: University of Umea, Department of Psychology.

Bauer, M. (1971). Prediction and probability judgment in a cue-probability learning task during two non-feedback phases (Umea Psychological Reports No. 54): Sweden: University of Umea, Department of Psychology.

Omission of feedback in a cue-probability leaning tasks has repeatedly been observed to raise cue-response correlations. It was suggested that this could be due to the scale level of the encoded task. Group induced to ration level encoding by means of explicit probability judgments were compared with a group without any instructions about scale level during two non-feedback phases, one immediately following the feedback session and the other one week later. The group making predictions only showed raised cue-response correlations when feedback was emitted, replicating earlier results. The effect was significant only for the retention interval of one week. The groups making conditional frequency estimates on the other hands showed an opposite trend, a regression of prediction proportions towards their estimation values. This effect also reached significance only for the longer retention interval. These results give some support to the suggested hypothesis.

Björkman, M. (1971). Consistency of a predictive policy under cue-event reversal. Umea Psychological Reports(55).

Tested the hypothesis that subjects do not differentiate the conditional probability p(Ei/Cj) from the conditional probability p(Cj/Ei) as clearly as demanded by probability theory. 80 undergraduates first learned a cue probability learning (CPL) task with two cues and two events and were then divided into four groups according to two levels of feedback (outcome feedback vs. no feedback) and two levels of change (no change vs. reversal of original task so that C was predicted from E rather than vice versa). Results support the hypothesis and

show that the group receiving feedback adapted to the reversed task. The data are interpreted to indicate that subjects do not adapt to a logical mode of inference under cue-event reversal in CPL.

Björkman, M. (1971). Consistency of subjective estimates of relative frequency and probability in cue probability learning (Umea Psychological Reports No. 51): Sweden: University of Umea, Department of Psychology.
After 100 trials of training with a cue probability learning task (two cues and two events) subjects were given 16 questions about the statistical structure of the material. These questions concerned four, kinds of events: marginal events, conjunctions conditional events E/C, and conditional events C/E. Half of the subjects estimated relative frequency of the events, the other half estimated probabilities of the same events. Though inaccurate the estimates conformed closely to the laws of probability theory. This was the case both for estimates of relative frequency and estimates of probability. The two kinds of estimates agreed very closely, which was interpreted as indicating that persons' concepts of probability (of recurring events) is identical to their experience of relative frequency.

Björkman, M. (1971). Policy formation as a function of feedforward in a non-metric CPL task. Umea Psychological Reports(49).

Brehmer, B. (1971). Concurrent learning of two single-cue probability learning tasks. Umea Psychological Reports(47).
Found that 96 high school students were able to learn to respond differentially to concurrent tasks, but the differences were smaller than when responding to the same tasks learned individually. Results suggest that part of the suboptimal use of cues in multiple-cue probability learning is due to interference effects.

Brehmer, B. (1971). Cue utilization in multiple-cue probability learning tasks with intercorrelated cues. Umea Psychological Reports(45).
Conducted a transfer experiment with 40 undergraduates. Results did not support the hypothesis that subjects learning a multiple-cue probability learning task with intercorrelated cues would match their cues to the correlations between the cues and the criterion, rather than to the cue-criterion beta weights.

Brehmer, B. (1971). Subjects' ability to use functional rules. Psychonomic Science, 24(6), 259-260.
Studied subjects' ability to assign numbers to lines according to four different rules: positive linear (PL), negative linear (NL), U-shaped (U), and inversely U-shaped (IU). Subjects were found to be more skilled in using the PL rule than all other rules and more skilled in using the NL rule than the two nonlinear rules. Implications of these results for functional and correlational learning, as well as for psychophysics, are discussed.

Brehmer, B., & Lindberg, L. A. (1971). Omission of feedback in single-cue probability learning. Umea Psychological Reports(46).
Found that the omission of feedback in single-cue probability learning results in an increase in the correlations between cues and judgments. This increase was due to an increase in the slopes of the regression lines relating 96 high school students' judgments to the cue values.

Castellan, N. J., Jr. (1971). Differential feedback in multiple-cue probability learning with binary dimensions : Paper presented at the Fourth Annual Conference on Human Judgment, University of Colorado at Boulder.

Knowles, B. A., Hammond, K. R., Stewart, T. R., & Summers, D. A. (1971). Positive and negative redundancy in multiple cue probability tasks. Journal of Experimental Psychology, 90(1), 157-159.
Tested 108 undergraduates on a 2-cue probability learning task in which the form (positive or negative) and magnitude (high or low) of stimulus redundancy were varied. An analysis of 50 learning trials revealed a significant main effect for form, as well as an interaction between form and magnitude. Learning occurred most rapidly in the task involving high positive redundancy and least rapidly in the task involving high negative redundancy. Findings are interpreted in terms of task characteristics which accompany redundancy. Implications for informational redundancy in learning tasks are discussed. ((c) 1997 APA/PsycINFO, all rights reserved)

Miller, P. M. (1971). Do labels mislead? A multiple cue study, within the framework of Brunswik's probabilistic functionalism. Organizational Behavior and Human Performance, 6, 480-500.
Abstract: Forty-nine clinicians, 49 statisticians, 124 first-year university students with moderate mathematical attainment, and 222 other first-year students predicted the examination results of 90 student stimulus persons. To do this they were given (a) the mid-term test results (b) the result on an essay written during the year, and (c) the result on an examination coolness test. These correlated +0.48, --0,32 and +0.18 respectively, with the examination result criterion. All subjects were told these correlation values, and in one of the nine conditions what the cues actually represented. In the other eight conditions the cues were either unlabeled or falsely labeled. Except for the statisticians, the achievement of subjects in those conditions where the cue labels logically conflicted with the ecological correlations was worse (at the 0.001 level) than that of subjects in the conditions where the correspondence was good. This applied also to two components of this achievement. The statisticians were the most accurate overall, followed by the clinicians, the mathematically students, and the other students, in that order. Some reflections are offered on the implications of these results for probabilistic functionalism.

Robbins, D., & Medin, D. L. (1971). Cue selection for multiple-cue probability training. Journal of Experimental Psychology, 91(2), 333-335.
Presented three pairs of letters to 26 college-age subjects in a 2-choice verbal discrimination paradigm. Each pair had an independent probability of being correct (pi). Within a pair these values were identical, while between pairs the reward probabilities differed. During training, subjects were given feedback only on the cue chosen. The training trials were followed by nonrewarded (no information) transfer tests consisting of all combinations of the letters. No preference was observed during training, but the transfer tests revealed a preference for the cue with the higher pi value in training. An information model (in which it is assumed that ss make inferences about outcomes associated with the unchosen cue of a pair but that these outcomes are less effective than directly received outcomes), and a variant of a "scanning model" were supported. ((c) 1997 APA/PsycINFO, all rights reserved)

Thorngate, W. B. (1971). On the learning and transfer of multi-cue judgement processes (Rep. No. 71-3): Edmonton: University of Alberta, Social Psychology Laboratories.

1972

Bauer, M. (1972). Bias in estimates of conditional probabilities and betting behavior

as a function of relative frequency and validity of cues in a cue-probability learning task. Acta Psychologica, 36(5), 337-347.
Employed 144 undergraduates in a study of the effects of cue probabilities and validities in a cue-probability learning task with two nonmetric cues and events effects. The design was factorial, with three levels of probability and two levels of both validities. Immediately after the learning session, subjects made a bet on the outcome of either of the cues and estimated some of the probabilities in the task. The hypothesis that the validity of the less frequent cue would be underestimated was confirmed. An opposite effect of overestimating the validity of the more frequent cue was also observed. Parallel results were obtained for betting behavior. There was a general tendency to choose the more frequent cue irrespective of cue validity. The tendency to disregard valid but rare information merits attention, since it promotes suboptimal decisions. ((c) 1997 APA/PsycINFO, all rights reserved)

Bauer, M. (1972). Relations between prediction- and estimation-responses in cue-probability learning and transfer. Scandinavian Journal of Psychology, 13(3), 198-207.
Made comparisons between the prediction- and estimation-responses of 192 undergraduates after training with different types of responding and when task probabilities were shifted. Learning procedure and shift in task structure had differential effects on predictions and estimates, supporting the hypothesis of two different processes. Estimates as indicators of probability learning reflected traits assumed to characterize the perception process (i.e., sensitivity to shifts in probabilities and robustness against influence from procedure of learning). Prediction-responses were affected in the direction of more extreme responses by simultaneous estimation. This result strengthens the supposition that probability estimates are insufficient as indicators of the complete perception process in a prediction task. (17 ref.) ((c) 1997 APA/PsycINFO, all rights reserved)

Björkman, M. (1972). Feedforward and feedback as determiners of knowledge and policy: Notes on a neglected issue. Scandinavian Journal of Psychology, 13, 152-158.
Studies of cognitive learning should distinguish between acquisition of knowledge and policy formation. Two learning operators, feedforward (i.e., task information by instructions) and feedback must also be considered. This double aim requires Es to analyze and relate two sets of data: subjective estimates about the task learned and prediction of outcomes. A broader approach is thus needed with a focus on how policy is related to knowledge, how these processes depend on feedback and feedforward, and how the latter two interact in producing knowledge and policy.

Brehmer, B. (1972). Cue utilization and cue consistency in multiple-cue probability learning. Organizational Behavior and Human Decision Processes, 8(2), 286-296.
Studied utilization of cues in a multiple-cue probability learning task as a function of task predictability and cue consistency. Twenty undergraduates served as subjects in each of two experiments. Results indicate that cue consistency had an effect on cue weights, but this effect was less pronounced for tasks with high predictability than for tasks with low predictability. Findings do not support the linear model description of cue utilization.

Brehmer, B., & Lindberg, L. A. (1972). Proactive transfer in single-cue probability learning: I. The effect of a variation in cue validity. Umea Psychological Reports(59).
Investigated proactive transfer in single-cue probability learning in two experiments with 32 undergraduates and 32 high school students. The original learning tasks and the transfer tasks differed with respect to cue validity (i.e., the correlation between cue and criterion) which was manipulated by a variation of the unaccounted for variance in the task. Results indicate

that subjects responded more rapidly to an increase in unaccounted for variance than to a decrease. The amount of change had no reliable effects on transfer. (17 ref.) ((c) 1997 APA/PsycINFO, all rights reserved)

Castellan, N. J. (1972). The analysis of multiple criteria in multiple-cue judgment tasks. Organizational Behavior and Human Decision Processes, 8(2), 242-261.
Discusses the linear "lens model" approach which has been widely applied to the analysis of subject performance in multiple-cue judgment tasks embedded in probabilistic environments. The model is generalized to situations involving several criteria about which judgments are to be made. It is shown that the various indices used in the single-criterion linear lens model are readily generalized to the multiple criterion case and may be given interpretations which are similar to those in the basic single criterion model. ((c) 1997 APA/PsycINFO, all rights reserved)

de Klerk, L. F., & Oppe, S. (1972). Functional cue learning under different probabilistic feedback conditions. Psychonomic Science, 29(6-B), 377-380.
Investigated single-cue learning in a study with 16 subjects in which the cue, the response (subject's estimation of the criterion), and the reinforcement (criterion) were varied in discrete steps. Two different cue criterion relationships (linear and quadratic) and two levels of probabilistic feedback were used. Results indicate that the linear function was more accessible than the quadratic function, and the task became more difficult when the criterion variance was increased. When the task required the subject to learn the quadratic function, he first attempted to improve the linear orthogonal component of this rule and then tried to improve the quadratic component. This effect is explained in terms of the progression hypothesis, i.e., subjects initially make use of the lower order components of the input and progress with practice to the higher order.

de Klerk, L. F., Oppe, S., & Truijens, C. L. (1972). Learning of positive linear functions under two different feedback conditions. Acta Psychologica, 36(6), 421-430.
Presented a learning task to 8 male 20-30 yr. olds which required subjects to infer a value of a criterion variable Y from that of a cue variable X. Four different linear functions $Y = a + bX$ and two different types of feedback were used. In Feedback Condition I, subjtects were informed about the correct value of Y at the end of each learning trial. In Feedback Condition II, subjects were informed about the value of X for which their estimations of Y were the correct responses. Results show that (a) inferences improve as learning progresses; (b) the type of feedback affects the degree of learning, with Condition II less effective than Condition I; and (c) performance depends largely upon the value of b (in $Y = a + bX$). It is suggested that perceptual factors may account for the latter result.

Deane, D. H., Hammond, K. R., & Summers, D. A. (1972). Acquisition and application of knowledge in complex inference tasks. Journal of Experimental Psychology, 92(1), 20-26.
Most studies of human inference have found that when the task requires that subjects utilize complex, nonlinear relations in order to make accurate inferences, performance is typically poor and improvement slow. It is proposed that the poor performance observed in such tasks can be explicated if performance is partitioned into two components: acquisition and application of task knowledge. Results of two experiments with undergraduates ($N = 100$) support the usefulness of a conceptual and methodological framework which provides a statistical referent for each component and which facilitates their disentanglement.

Hammond, K. R., & Summers, D. A. (1972). Cognitive control. Psychological

Review, 79(1), 58-67.
Performance in cognitive tasks involves two distinct processes: acquisition of knowledge and cognitive control over knowledge already acquired. A conceptual and analytic framework is presented which allows for the disentanglement of knowledge and control, and for the quantification of each. Evidence from studies of multiple-cue probability learning, clinical judgment, and interpersonal conflict supports the theoretical usefulness of this framework and indicates that poor performance in cognitive tasks can often be attributed to incomplete cognitive control rather than incomplete knowledge. The importance of cognitive feedback as opposed to traditional outcome feedback for the development of cognitive control is illustrated.

Jenkins, R. (1972). Deprivation conditions in multiple-cue probability learning (Report 72-14). Bloomington: Indiana University, Department of Psychology, Indiana Mathematical Psychology Program.

Knowles, B. A., Hammond, K. R., Stewart, T. R., & Summers, D. A. (1972). Detection of redundancy in multiple cue probability tasks. Journal of Experimental Psychology, 93(2), 425-427.
Gave 36 undergraduates a 2-cue probability learning task in which both the sign (positive or negative) and magnitude (high or low) of stimulus redundancy (cue intercorrelation) were varied. Subsequently, subjects judged each of a set of cue combinations as being likely or unlikely to occur. For each subject, the cue intercorrelation and standard error of estimate were determined from the combinations judged likely to occur. Learning of the cue intercorrelations did occur, although the accuracy of subjects' estimates varied with both sign and magnitude of the intercorrelation. Previous results from cue-criterion learning studies are thus found to generalize to the learning of cue intercorrelations. ((c) 1997 APA/PsycINFO, all rights reserved)

Montanelli, D. S. (1972). Multiple-cue learning in children. Developmental Psychology, 7(3), 302-312.
Investigated children's ability to use multiple sources of information in making judgments using the Brunswik lens model. Approximately equal numbers of males and females (N = 144) from Grades 3, 5, 7, and 9 were asked to use the color, form, and border of each of 128 stimuli to determine how far to move a lever across a slot. Subjects were then shown how far they should have moved the lever. The correct distance was determined by the formula 2C1 + 1.5C2 + C3 = LD, where the Cs represent the three cues (color, form, and border) and LD, lever displacement. Results indicate that (a) subjects were able to use multiple cues simultaneously in making judgments, (b) there was a general tendency for performance to improve with age, (c) there was a tendency (increasing over trial blocks) for subjects to use the cues in the correct order (most valid, intermediately valid, and least valid), (d) subjects tended to rely primarily on only two cues in making their judgments, and (e) males tended to respond to the most valid cue more than females. (24 ref.) ((c) 1997 APA/PsycINFO, all rights reserved)

Turnis, M. F. (1972). Generality of accuracy in interpersonal learning. Dissertation Abstracts International, 33(1-B), 431.
An attempt was made to study the generality of accuracy in interpersonal learning. Independent variables were different sets of feedback values and different sets of instructions for three cue probability learning tasks. Each judge responded to the items making up the

tasks prior to receiving feedback and to more than one of the tasks with feedback. Learning was operationally defined as an increase in the accuracy with which a judge's responses estimated the criterion for the tasks on which he received feedback compared to the accuracy with which his responses before feedback estimated the same criterion. Judges assigned to the interpersonal learning group received feedback in a cooperative learning task. After recording their estimate of the criterion for each stimulus they arrived at a joint estimate with a partner who was a cohort of the experimenter. On the last twenty trials the judge and the cohort did not make joint estimates but were asked to record their prediction of, what their partner estimated on that trial. Interpersonal learning was operationally defined as an increase in the accuracy with which the judge's (or cohort's) prediction of his partner's estimate matched his partner's estimates compared to the accuracy with which each person's initial predictions of the estimate of a typical college student matched their partner's estimates. In groups which participated in three learning tasks, Kendall's Coefficient of Concordance was the measure of generality of rankings of judges from least accurate to most accurate. In the interpersonal learning group the Spearman Rank Correlation between the accuracy of judges on the two tasks was used as the measure of generality. No evidence for generality of interpersonal learning was found in the present study. Low levels of interpersonal learning were interpreted as due to the restriction on verbal discussion in the present procedure. Pairing of judges and cohorts with similar dominance scores resulted in lower levels of accuracy for the joint estimates of the criterion and judges' predictions of cohorts' responses than pairing of judges and cohorts With dissimilar dominance scores. When the judge and the cohort had similar dominance scores, those pairs with high dominance scores were more accurate in their joint estimates than those pairs with low dominance scores. These results support the implication of other studies that accuracy of prediction by human judges is not a salient trait. This suggests the need for considering accuracy as a trait which may be multiply-determined by such variables as task demands, individual differences in response styles, type of information employed and the interactions among such variables.

van Bolhuis-Bouma, A., & Oostlander, A. M. (1972). Multiple cue probability learning: An experiment with circular dimensions. Organizational Behavior and Human Decision Processes, 7(3), 383-396.

Describes a study with 23 undergraduates applying methods from Brunswik's lens model to a learning task in vector composition in which only an indication of the direction of the vectors was given. Feedback consisted of the direction of the resultant vector. The task was to learn the relative weights of three stimulus vectors which determined the direction of the resultant vector, under three levels of predictability. Subjects received 140 learning trials followed by 80 transfer trials (a) where the weights of the most and least important stimulus dimensions were reversed, or (b) without any feedback. Results indicate a two-stage learning process in which subjects learned the general structure of the task and then stabilized their response strategy. There was a trend towards optimizing behavior; probability matching could not account for the results. It is concluded that these judgmental processes are of an automatic, not clearly verbalizable, character. Whatever the quality of performance, verbal reports were very global.

1973

Allmeyer, D. H., & Medin, D. L. (1973). Reward information and cue selection

following multiple-cue probability learning. Journal of Experimental Psychology, 99(3), 427-429.
Told 48 college-age subjects in a probability-reinforced, 2-choice verbal discrimination problem either to assume that the outcomes within a pair of cues were mutually exclusive or that the outcomes within a pair were independent. Each cue had an independent probability of being correct (r), and within a pair these values were identical; however, between pairs, the reward probabilities differed. On transfer tests involving all possible pairings of the six alternatives, subjects told that the outcomes were independent preferred the higher r values, and subjects told the outcomes were mutually exclusive displayed much less (but still significant) selection. The training data tended to support a pattern, rather than a linear model, for learning. ((c) 1997 APA/PsycINFO, all rights reserved)

Armelius, B. A., & Armelius, K. (1973). Detection of cue intercorrelation and cue validities in a multiple-cue judgment task with a suppressor cue. Umea Psychological Reports(74).
Tested 42 undergraduates' detection of cue intercorrelation, rij, and cue validities, rei, after completion of a learning task with three levels of rij (.00, .40, and .80). The detection was examined by means of reproduction of rij in one test condition, and rei in another. The reproduced rij values in the two redundant conditions closely matched those of the learning tasks. There were, however, no differences among reproduced rij values which was explained as a positive set in the rij = .00 condition. The reproduced rei values were generally close to those of the task with the exception of the nonvalid cue for the rij = .00 condition, which was greatly overestimated. It is concluded that the poor performance in suppressor variable tasks is due to the subjects' inability to adjust the weights given to the cues, rather than to poor learning of rij and rei.

Bauer, M. (1973). Prediction strategies in non-metric probability learning tasks when feedback is omitted (Umea Psychological Reports No. 62): Sweden: University of Umea, Department of Psychology.
Forty eight undergraduates predicted binary events for two cues and received immediate feedback in a nonmetric cue-probability learning task. In a second session immediately after learning or one week later, subjects continued predicting, although feedback was omitted, and subjects had to base their responses on whatever had been learned during the feedback phase. Task descriptions were made in terms of conditional events and on ordinal scale level; proportion descriptions were rare. Relationships between categories of description and prediction strategies were obtained. Differences in average prediction strategies for subjects making their descriptions before vs. after the nonfeedback test are noted.

Bauer, M. (1973). Subjective representation and prediction in probabilistic inference tasks (Project Report): Sweden: University of Umea, Department of Psychology.
Subjective task representation is a significant cognitive process in probabilistic inference just as well as in related tasks like concept formation and problem solving. In cue-probability learning (CPL) task representations were affected by concurrent estimation (Bauer, 1971b, 1972a), task structure (Bauer, 1972b) and omission of feedback (Bauer, 1971c, 1973b). In Bayesian statistical inference (BSI) the subjective task representation was found to be very different from the normative model of the sampling distributions, both concerning sample- and population-characteristics, which, furthermore, shifted with changes in experimental procedure (Bauer, 1973a). Response bias and stereotypy were observed for numerical judgments (Bauer, 1971a) as well as for simple acts (Bauer, 1973a). In research on verbal

learning and memory it has become evident that subjects construct a task representation according to any available principles for organization, and when no such principles are apparent they are devised by subjects. Organization of input is assumed to fulfill the function of overcoming the organism's limited capacity of storage and retrieval (Postman, 1972). Transferred to probabilistic inference tasks this assumption would imply that subjects attack the problem by searching for deterministic rules or other principles that allow effective organization of the input and a consistent response strategy. Neither the CPL nor the BSI task supplies subjects with an unequivocal principle for such organization. Subjects are therefore forced to choose among available alternatives or to devise a principle that allows a consistent behavior and reduces cognitive strain. The considerable individual differences obtained in CPL tasks would then be a consequence of the diffuse character of this task from the subjects' point of view. It would also explain the factional effects of concurrent estimation and description, in that these procedures enhance the salience of certain features of the task, which are then readily used as principles of organization at storage and as cues at retrieval. Results from various types of BSI tasks also become ware intelligible and consistent when examined from the viewpoint of the organism's capacity for information processing than from normative assumptions of intuition for numerical probabilities and statistical sampling distribution nor with any alternative fixed model. More likely it shifts with the salient characteristics of the task at hand. Thus, sample characteristics are more concrete than population diagnosticity in this form of the task, while the opposite may be the case in the procedure used by Kahneman and Tversky (1972); Different sample characteristics are enhanced by different experimental procedures, and sample size affects the relative salience of a specific outcome. These shifts in subjective parameters with experimental procedures together with small individual differences in parameters used within a specific paradigm support the hypothesis of the importance of salience of task features for representation and achievement. The experimental facts, and the speculative arguments presented in this summary, together constitute a demand for an extension of research strategies and explanatory concepts in research on probabilistic inference with the aim to detect more essential features of the environment and general principles of organism processes and less artifacts of a single model or method.

Björkman, M. (1973). Inference behavior in nonmetric ecologies. In L. Rappoport & D. A. Summers (Eds.), Human judgment and social interaction (pp. 144-168): New York, USA: Holt, Rinehart and Winston, Inc.

The first part of this chapter is methodological and presents lens model concepts in a way appropriate for the nonmetric situation. The second part illustrates the use of these concepts in experimental studies. Outcome feedback is found to be an interfering factor in probabilistic C-E learning.

Bonaiuto, G. B. (1973). The feedback problem: Cognitive change in conditions of exact and ambiguous outcome feedback. In L. Rappoport & D. A. Summers (Eds.), Human judgment and social interaction (pp. 218-228): New York, USA: Holt, Rinehart and Winston, Inc.

In comparison with exact feedback, ambiguous feedback appears to prevent cognitive change. Feedback may interact with initial cue learning in such a way that linearly trained subjects are influenced by different types of feedback, while curvalinearly trained subjects are not.

Brehmer, B. (1973). Effects of cue validity on interpersonal learning of inference

tasks with linear and nonlinear cues. American Journal of Psychology, 86(1), 29-48.
Describes an experiment in which 54 pairs of undergraduates learned to infer the state of a criterion variable from that of the cues (one linear and one nonlinear) in a 2-cue inference task. The distribution of the cues' validities varied in five conditions. Subjects learned the systematic features of their tasks equally well in all conditions, but achievement was lower in the predominantly nonlinear ones, where subjects used the cues less systematically than they did in the predominantly linear conditions. Subjects also apparently gave too much weight to the communication from the other subject in the pair, and too little weight to the feedback from the task. (28 ref.) ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B. (1973). Effects of task predictability and cue validity on interpersonal learning of inference tasks involving both linear and nonlinear relations. Umea Psychological Reports(66).
Gave 48 pairs of undergraduates 2-cue inference tasks with one linear and one nonlinear cue. Task predictability and the distribution of the validities of the cues were varied in a factorial design. Subject adjusted their utilization of the cues to the magnitudes of the validities of the cue. As a consequence, relative achievement was lower when task predictability was low. Nonlinear cues received lower weights than linear cues, and suffered a further reduction when they were used in conjunction with linear cues. Achievement was lower when only the nonlinear cue was relevant than when only the linear cue was relevant, and lower when both cues were relevant than when only one cue was relevant. When subjects who started out using only the valid cue were paired with subjects who used a nonvalid cue, they started to use the nonvalid cue. This suggests that interpersonal learning may introduce bias in the utilization of cues. (21 ref.) ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B. (1973). Note on the relation between single-cue probability learning and multiple-cue probability learning. Organizational Behavior and Human Decision Processes, 9(2), 246-252.
Assigned 96 18-yr-old high school students to six groups in which they learned pairs of single-cue probability learning tasks concurrently. Although subjects learned to respond differently to the concurrent tasks, the differences in responding to these tasks were smaller than the differences between the same tasks learned one at a time. This suggests that the concurrent tasks interfered with each other. Interference effects were asymmetric-a low validity cue interfered more with the learning of a high validity cue than vice versa. Results for the concurrent tasks parallel those for concurrently learned cues in multiple-cue probability learning. It is suggested, therefore, that at least part of the suboptimal use of the cues in multiple-cue probability learning is due to interference effects. ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B. (1973). Single-cue probability learning as a function of the sign and magnitude of the correlation between cue and criterion. Organizational Behavior and Human Decision Processes, 9(3), 377-395.
Investigated the effects of the sign and magnitude of the cue-criterion correlation, rce, the slope of the cue-criterion regression line, bce, and the magnitude of the unaccounted for variance in the task system sce2, upon single-cue probability learning in three experiments. Subject were 96 high school students. Positive cue-criterion relations were learned faster than negative relations, and tasks with high values of sce2 were learned faster than tasks with low values of sce2. The final level of performance was, however, determined only by rce. At this level, the cue-response correlations exceeded rce. The amount of overshooting was

an inverse function of rce, because subjects' prediction strategies were more extreme for low than high levels of rce. The relative consistency of their response systems was, however, not affected by rce. ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B., & Lindberg, L. A. (1973). Retention of single-cue probability learning tasks as a function of cue validity, retention interval, and degree of learning. Journal of Experimental Psychology, 101(2), 404-406.
Studied retention of single-cue probability learning tasks with scaled cue and criterion variables in a 2 x 3 x 3 factorial experiment with two levels of cue validity (.43 and .89); three degrees of learning (complete learning, 100% overlearning, and 200% overlearning); and three retention intervals (retest immediately after the completion of the learning stage, after 24 hr, and after one wk). Subject were 144 undergraduates. Results are consistent with those of earlier studies in that subjects showed no evidence of forgetting over the one-week interval, but there were no effects of the degree of learning factor. ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B., & Lindberg, L. A. (1973). Retroactive transfer in single-cue probability learning: I. The effect of a variation in cue validity. Umea Psychological Reports(63).
Studied retroactive transfer as a function of the direction and magnitude of change in cue validity from the original learning (OL) to the interpolated learning (IL) stage. Cue validity was manipulated by changing the unaccounted-for variance in the task. Results show that retroactive transfer was determined by the change in cue-criterion correlation from the OL to the IL task rather than by the difference in variances. Positive transfer was obtained when the correlation for the IL task exceeded that for the OL, and negative transfer was obtained in the reverse situation. ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B., & Qvarnstrom, G. (1973). Feedforward, feedback, and subjective weights in multiple-cue judgments. Umea Psychological Reports(76).
Used a fictitious medical diagnosis task to study how subjects integrate information from multiple cues, how they interpret the concept of weight in a multiple-cue judgment task, how they infer weights from experience with the task, and whether or not they are able to report the weights they are using. Results with 60 undergraduates show that (a) most subjects integrated the information additively; (b) they interpreted the concept of weight in terms of slopes or correlations, rather than in terms of variance accounted for by the cues; and (c) they could not infer the optimal weights from experience. However, subjects were able to report their weights, and the reported weights corresponded closely to the correlations between the cues and the judgments, but not to the variance in the judgments accounted for by the cues. ((c) 1997 APA/PsycINFO, all rights reserved)

Castellan, N. J. (1973). Comments on the "lens model" equation and the analysis of multiple-cue judgment tasks. Psychometrika, 38(1), 87-100.
Discusses the lens model approach to analysis of subjects' performance in multiple-cue judgment tasks embedded in probabilistic environments. Various characteristics of the linear lens models are presented in matrix notation and are formulated without reference to standardized variables in order to facilitate analysis and subsequent generalization. New results on matching behavior are described, and a brief outline of current problems and related work is presented. (29 ref.) ((c) 1997 APA/PsycINFO, all rights reserved)

Castellan, N. J. (1973). Multiple-cue probability learning with irrelevant cues. Organizational Behavior and Human Decision Processes, 9(1), 16-29.
Investigated the effect of irrelevant cues on performance in a multiple-cue probability

learning task with binary cues and events. 595 undergraduates were assigned to 24 groups in a 4 (validity of relevant cue dimension) x 3 (number of irrelevant cue dimensions) x 2 (replications) factorial design and were run for 400 noncontingent trials. Analysis of the data indicates that (a) the number of irrelevant cues had an effect on performance which diminished but did not disappear across trials; (b) there was an interaction between number of irrelevant cues and the validity of the relevant cue, the resultant performance decrement being greatest for relevant cues of moderate validity. A cue selection hypothesis model consistent with the data is briefly outlined. (15 ref.)

Castellan, N. J., & Edgell, S. E. (1973). An hypothesis generation model for judgment in nonmetric multiple-cue probability learning. Journal of Mathematical Psychology, 10(2), 204-222.

Presents a two-phase hypothesis generation model to describe behavior in learning tasks with nonmetric cues. The model assumes that on each trial the subject generates two sets of hypotheses: (a) one concerning which cue dimension (or pattern) will lead to a correct prediction on that trial and (b) one concerning which response will be correct given the cue dimension attended to on that trial. To test the model, 512 undergraduates were assigned to 20 groups in a binary choice task involving two binary cue dimensions. Each group observed cues which differed in validity. Analysis of the data indicates that subjects attended to both cue dimensions in making judgments even when one cue has zero validity. A test of the fit of the observed data to the asymptotic response proportions predicted by the model indicates a reasonable fit. (16 ref)

Connolly, T., & Miklausich, V. (1973). The effects of error-prone outcome feedback on learning and performance in a multiple-cue judgment task. Atlanta: Georgia Institute of Technology.

Abstract. Most reported laboratory studies of human learning of judgment tasks have used error-free outcome or "right answer" feedback. It is here argued that practical judgment skills are commonly acquired in environments where outcome feedback, when available, is considerably error-prone with respect to the underlying variable, and that such feedback error may be distinguished from situations in which Re2 is less than unity. An experiment examining the effects of three feedback error levels on learning, and performance in two simple judgment tasks is reported. The data indicate that increasing feedback error is associated with performance degradation, primarily via its impact on the subject's cognitive control. There is some evidence that learning acquired under low feedback error conditions is more stable than is learning acquired under high feedback error conditions. Some areas for extension and application of these findings are suggested.

Dudycha, A. L., Dumoff, M. G., & Dudycha, L. W. (1973). Choice behavior in dynamic environments. Organizational Behavior and Human Decision Processes, 9(2), 328-338.

Examined the effects of shifting ecological validities in two single-cue environments (re: .895<.634 and .634<.895) on 180 undergraduates' consistency and achievement. Amount of information about the shift and the number of preshift trials were also varied. Results show a significant order effect and that subjects probability matched under both preshift ecologies but highly overstructured in the .634 postshift ecology and understructured in the .895. Differential performance across blocks was observed for the postshift ecologies. No systematic effects were obtained for the information and number of preshift trial variables.

Results are discussed in the frameworks of Brunswik's 1952 lens model and the AB-BA transfer paradigm. (19 ref.) ((c) 1997 APA/PsycINFO, all rights reserved)

Earle, T. C. (1973). Intuitive and analytical thinking in consistent and inconsistent multiple-cue learning tasks. Unpublished doctoral dissertation, University of Colorado, Department of Psychology.

The focus of this study is on the contrasting characteristics of intuitive and analytical thinking. The theoretical properties of these two modes of thought are first described, followed by an experimental investigation of the distinction. An attempt is made, within the framework of multiple-cue learning tasks, to determine two sets of task conditions; one in which the intuitive mode is superior to the analytical mode. The determination of these task conditions should provide insight into the general problem of task learning, as well as clarify the concepts of intuitive and analytical thinking.

The treatment of the intuitive-analytical continuum in the present study derives from that of Brunswik and followers. A summary of the Brunswikian position can be made in four points:

1. There is a continuum of ratiomorphic cognitive functioning ranging from intuitive to analytical thinking. Most thinking is quasi-rational, consisting of some mix of intuition and analysis.
2. Thinking toward the intuitive end of the continuum in relatively unaided, perception-like thinking. Operating in the intuitive mode, a person does not consciously impose transformations on information.
3. Thinking toward the analytical end of the continuum is relatively aided thinking. Operating in the analytical mode, a person consciously imposes transformations on information.
4. As consequences of the three preceding points: (a) thinking in the intuitive mode is fast, uses a variety of information, has a low degree of awareness, and is seldom precisely correct or drastically wrong; (b) thinking in the analytical mode is slow, uses a limited range of information, has a high degree of awareness, and when wrong produces large errors.

The two tasks used in this study differed only in consistency. As used here, a consistent task is one in which Re = 1. 00; an inconsistent task is one in which Re < 1.00. Each task was composed of two independent cues, one of which was unrelated to the criterion. In both tasks the valid cue was related to the criterion by means of a rule with an inverted U-shaped form. Half the subjects were assigned to the consistent (Re = 1.00) task, the other half to the inconsistent (Re = .95) task. Each subject completed 90 trials on the task to which he was assigned. The two modes of thinking, intuitive and analytical, were induced through instructions and task materials. The instructions for intuitive subjects emphasized quickness of judgment, the use of immediate impressions. The instructions for the analytical subjects, on the other hand, emphasized slow, deliberate reasoning. The stimulus materials contained both graphical and numerical designations of stimulus values; intuitive subjects were encouraged to use the graphical information, while the analytical subjects were encouraged to use the numerical information. Finally, intuitive subjects were provided with nothing they could manipulate as an aid to calculation and memory; analytical subjects, however, were given paper and pencil to use in whatever manner they found useful in the task. The results of this study supported the hypothesis in that task consistency was shown to be a critical variable. Specifically, intuitive subjects performed better than analytical subjects in the inconsistent (R, = .95) task, while analytical subjects were superior in the consistent (R, =

1.00) task. The results also showed that the intuitive and analytical subjects performed in the contrasting manners described by Brunswik. The implications of these results for further experimentation, as well as for theory development, were discussed.

Earle, T. C. (1973). Interpersonal learning. In L. Rappoport & D. A. Summers (Eds.), Human judgment and social interaction (pp. 240-266): New York, USA: Holt, Rinehart and Winston, Inc.

Three studies were conducted following the lens model research paradigm. The first study focused on context of information and rule complexity. Simple (linear trained) subjects required interpersonal learning from complex (nonlinear trained) subjects in order to learn to use a complex (nonlinear) rule; complex subjects did not require interpersonal learning from simple subjects in order to learn to use a simple rule. The second study concerned variations in rule complexity. Simple rules (i.e., positive linear) could be learned from task information, but complex rules (i.e., negative linear, inverted U-shaped, and U-shaped) required the exchange of interpersonal information concerning their form before they could be used. The third study showed that interpersonal learning was not notably different from individual task learning, except when the other person can convey information relevant to the task. Complex relationships can then be learned much more easily because persons trained on a simple rule benefit from contact with those who are familiar with a complex rule.

Edgell, S. E., & Castellan, N. J. (1973). Configural effect in multiple-cue probability learning. Journal of Experimental Psychology, 100(2), 310-314.

Used a nonmetric multiple-cue probability learning task involving two binary cue dimensions with 198 undergraduates. Three experiments were conducted varying in the number of cue dimensions having relevant and/or irrelevant information. It was found that subjects can learn to use configural or pattern information (a) when only the configural information is relevant; and (b) when, in addition to the configural information, 1 or both of the cue dimensions are relevant. Hypothesis-generation models of nonmetric multiple-cue probability learning are considered.

Gillis, J. S., & Davis, K. E. (1973). The effects of psychoactive drugs on complex thinking in paranoid and nonparanoid schizophrenics: An application of the multiple-cue model to the study of disordered thinking. In L. Rappoport & D. A. Summers (Eds.), Human judgment and social interaction (pp. 170-184): New York, USA: Holt, Rinehart and Winston, Inc.

Found that paranoid individuals were inferior on narrow-focused mcpl tasks, which is consistent with the notion that they have much difficulty ignoring irrelevant aspects of their environment. There was no difference in performance between paranoid and nonparanoid individuals on wide-focus mcpl tasks.

Gillis, J. S., Stewart, T. R., & Gritz, E. R. (1973). New procedure: Use of interactive computer graphics terminals with psychiatric patients. In K. R. Hammond & C. R. B. Joyce (Eds.), Psychoactive drugs and social judgment: Theory and research (pp. 217-237): New York: John Wiley and Sons.

Results from three mcpl experiments with four 3-cue tasks lead to four primary conclusions: (1) interactive computer graphics techniques can be used with psychopathological populations and with individuals on a variety of chemotherapeutic regimens; (2) these methods appear to be sensitive to drug effects; (3) the type of feedback given, made possible by interactive computer graphics, is as critical for judgmental learning with drug-pathological groups as it is for normal college students; and (4) while both knowledge and control

parameters are effected by an individual's drug pathology status, feedback efficacy is primarily a function of the enhanced cognitive control induced by interactive computer graphics presentations.

Hammond, K. R., Summers, D. A., & Deane, D. H. (1973). Negative effects of outcome-feedback in multiple-cue probability learning. Organizational Behavior and Human Decision Processes, 9(1), 30-34.

Studied performance in a probabilistic learning task under conditions in which 30 undergraduates received (a) knowledge of results after every trial (outcome-feedback), (b) information about task properties, and (c) both outcome-feedback and information about task properties. Results show that outcome-feedback was not only unnecessary for improved performance but impeded performance as well.

Hoffman, P. J. (1973). Partial differential feedback: An on-line training configuration for the optimization of multidimensional cue learning. Behavior Research Methods, Instruments and Computers, 5(2), 161-164.

Describes a PDP-9 computer configuration arranged for experimental research into the acquisition of judgmental skill. The system is designed to overcome certain deficiencies noted in stimulus-response-outcome paradigms. The configuration departs radically from traditional approaches in that (a) the stimulus is placed under subjects' control; (b) the requirement for a response is eliminated; (c) outcome feedback is a continuously changing function of the multiattribute stimulus settings under the control of subjects; and (d) the configuration makes possible the rapid learning of an essential feature of such learning tasks, i.e., partial derivatives of the criterion or outcome variable with respect to each of the stimulus attributes.

Jankowicz, A. Z. (1973). Feedback for learning in business games. Simulation and Games, 4(2), 175-203.

One of the difficulties in the assessment of the teaching effectiveness of simulation exercises has been the lack of a measure of learning which would allow observation and subsequent control of the learning process while the exercise is taking place. Existing attempts to observe the learning process are subdivided into those which involve measurement external to the simulation session (i.e., methods which compare the performance of participants on a test of knowledge gained during a simulation exercise of one type with performance on another type) and those which involve internal measurement (i.e., methods which afford observation while the exercise is taking place). Two classes of methods were observed which are well tried in evaluation research, which have strong advantages in certain situations, but which are not particularly useful-nor, indeed, intended-for the observation of learning as it occurs. Two candidates for a more appropriate measure are presented. The first measure is an outcome of applying Brunswik's Lens Model to the business game situation, in which a true state of a particular element in the game situation model can be identified by an appropriate allotment of weightings on a set of cue variables. The second and suggested model is an adaptation of a standard approach in the evaluation of subjective probability assessments.

Lindberg, L. A. (1973). Experimental studies of decision making in uncertain environments. Pilot study: Construction and test of an experimental paradigm. MPI B Rapport(94), 20.

Constructed a decision situation of the multiple-cue probability learning (MPL) type, where a

subject's task was to learn to combine information from a number of uncertain cues to predict the state of a decision variable (criterion). The MPL task was designed for analysis of feedback effects and for analysis of progression and regression effects of the kind previously found in tracking behavior. The physical variables of position, velocity, and acceleration of a moving point were used as cues. Numbers from 1 to 99 constituted the criterion variable. Seven subjects performed the task on line with a PDP 12 computer in a training stage, during which outcome feedback was provided, and in two retention stages without feedback. Results indicate that the experimental paradigm, after certain adjustments, is well suited for the intended purpose. Concrete measures for improving the paradigm are discussed. (20 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Muchinsky, P. M. (1973). The influence of a suppressor variable in multiple cue probability learning. Dissertation Abstracts International, 34(6-B), 2974.

Abstract. The purpose of this study was to investigate the effect of a suppressor variable in a multiple cue probability learning task. Also of major interest was the effect on subject performance of utilizing labels to induce a psychologically relevant context in such a task, as opposed to an environment free of any such context. Subjects made 150 estimates of the criterion based upon cues which had been generated in blocks of 25 to reflect desired correlative relationships. A repeated measures analysis of variance design was used to analyze the data. The dependent variables included subject achievement, consistency, and matching. Seven separate experiments were conducted. The first five experiments were primarily concerned with the effect of a suppressor variable on subject performance. Each of these experiments consisted of a series of treatment and control conditions, run under different levels of system predictability and under two types of instructions (label and no label). The label instruction conditions involved presentation of the stimuli in the context of a consumer loan problem. where subjects predicted a loan applicant's credit score based upon two pieces of financial information (amount of monthly debt and average number of creditors). Experiments One through Four involved cues with positive validities, while Experiment Five employed negative cue validities. The last two experiments were concerned with the effect of instructions, cue validity sign and cue intercorrelation sign on subject performance. Results for Experiments One through Five indicated that subject achievement in the treatment conditions was superior to achievement in the control conditions, but only under label conditions. However, subject consistency and matching in the treatment conditions was in most cases not superior to such performance measures in the control conditions. The results suggest that subjects can utilize the suppressor effect in making predictions in a psychologically meaningful context, although its influence does not necessarily facilitate a consistent environmental matching strategy. Results for Experiments Six and Seven indicated that subject achievement was superior in conditions involving labeling instructions and positive cue validities. Likewise, subjects developed more consistent strategies in these conditions. The findings suggest that subject performance in a decision making task is enhanced by a structured context, and when the cues have a direct or positive relationship with the criterion. The latter finding was evidenced even though the intuitively logical relationship existing between the cues and criterion was negative (the lower the number of creditors, the higher the credit score). Subject matching was also enhanced in label conditions, and was found to be superior when the cues were negatively intercorrelated. It appears that subject matching was facilitated by the negative intercorrelation because the cues were more distinguishable than when they were positively

intercorrelated. The effects of instruction, cue validity sign, and cue intercorrelation sign on subject performance in this study support similar findings from previous research.

Nystedt, L., & Magnusson, D. (1973). Cue relevance and feedback in a clinical prediction task. Organizational Behavior and Human Decision Processes, 9(1), 100-109.
Performed an experiment on the effect on individual judges' predictive efficiency of information about the relevance of cues for clinical judgments. The information patterns were such that the task may be characterized as a multiple-cue probability task. 12 experienced undergraduates judged the achievement of 30 undergraduates on the basis of the results of 5 tests. The predictive efficiency was shown to be substantially and significantly higher with access to the ecological validity coefficients than without such information. Feedback in the form of utilization coefficients and functional validities had no additional positive effect.

Schmitt, K. L. (1973). The effect of cue validities and cue redundancy with predictability held constant in multiple cue probability learning tasks. Dissertation Abstracts International, 33(9-B), 4563.
Past studies attempting to determine the effect of cue redundancy within the lens model paradigm were criticized because in no instance was cue intercorrelation manipulated independently of both cue validities and total task predictability. In the present study, subjects' ability to learn two-cue tasks in which both task predictability and cue validities were held constant while cue intercorrelation varied was studied. Five separate experiments were conducted. In two of the experiments, cue validities were .80 and .60 and task predictability was either .90 or .70. In the other three experiments, cue validities were .60 or .20 and task predictability was .90, .70, or .40. In addition, the sign of the cue validities was varied. Within any one experiment, then, the following variables were manipulated: (1) the positive or negative nature of the cue criterion relationship, and (2) the cue intercorrelation. The dependent variables included subject achievement, consistency, and matching. Subjects made 150 estimates of the criterion based on 150 pairs of cues which had been generated to reflect the desired correlative relationships within blocks of 25. Data were analyzed by means of a 2 (2 levels of cue intercorrelation) X 2 (positive or negative cue validities) X 6 (trial blocks) repeated measures analysis of variance. All factors except subjects were considered fixed. High cue intercorrelation resulted in significantly lower subject achievement when task predictability was high (re2 = .90) and when the difference between low and high cue inter correlation was most extreme (rl2 = .12 vs. .95). Subject consistency was greater in conditions of high cue redundancy--this difference being most extreme when performance of groups in which cues were negatively intercorrelated was compared with performance in groups in which the cues were positively intercorrelated. Subject matching was significantly greater in conditions of low cue redundancy than in orthogonal or low redundancy conditions. Again, this difference was most extreme when comparing performance between groups in which the cues were negatively intercorrelated with groups in which the cues were positively intercorrelated. Subjects were unable to match their beta weights to those of the ecology when cue intercorrelation was high and positive. Performance on all three indices in the negative validity conditions was very low with little or no evidence of learning.
Subjects' overall performance (achievement) was not increased by high redundancy. Though cue redundancy aided the subjects in that they consistently weighted cues in the same manner, they were unable to discriminate properly between cues when the cues were highly

intercorrelated. Subjects' inability to recognize and use cues which were negatively related to the criterion was consistent with earlier findings concerning utilization of negative information.

Thorngate, W. B. (1973). On the learning and transfer of multi-cue judgement processes. Dissertation Abstracts International, 33(7-B), 3362-3363.

Three experiments employing a multiple cue probability learning situation were conducted to determine how multi-cue judgement processes are learned and transferred. Each subject was required to predict one of two responses (yes or no) to questions ostensibly answered by four types of stimulus persons each described by values on two dichotomous dimensions marital status (married or single) and sex (male or female). In the pretest subjects were required to predict, without feedback, each stimulus person's responses to two such questions which varied in their relatedness. In the learning phase subjects continued to predict responses to only one of the two questions but after each prediction they were given feedback about its correctness. In the estimation phase subjects were required to estimate the proportion of yes responses given by each of the four types of stimulus person (married males, married females, single males and single females) and by each of the four stimulus characteristics (marrieds, singles, males and females) on the basis of feedback received in the learning phase. In the posttest subjects were again required to predict, without feedback, each stimulus person's responses to the two questions in the pretest. Each of the three experiments varied the proportion of yes responses given by the four stimulus types. Half the subjects in Experiment I learned and estimated proportions that varied as a function of a main effect of one stimulus dimension (an Additive function), the remainder learned and estimated proportions that varied as a function of the interaction between both stimulus dimensions (an Interactive function). All subjects in Experiment 11 learned and estimated proportions that varied as a function of the main effect of one stimulus dimension and the interaction between both stimulus dimensions (a Composite function). And all subjects in Experiment III learned and estimated proportions that varied as a function of the main effects of both stimulus dimensions (a Compound function). The results of Experiment I indicated that the interactive function was learned at an almost identical rate as the Additive function. This supported a class of learning models which assumed that both functions were learned by associating responses with stimulus types or configurations, rather than by associating responses with stimulus characteristics or dimensions. The results of Experiment II indicated that the interaction component of the Composite function was learned more slowly than its main effect. This supported a class of judgement models which assumed that when responses to a stimulus type had not yet been learned, predictions about this type were made by extrapolating from similar stimulus types with learned associations. The results of Experiment III indicated that parameters of the extrapolation process underwent significant changes over time. Over all three experiments the time taken to estimate the proportion of yes responses to each stimulus type was shorter than the time taken to estimate the proportion of yes responses to each stimulus characteristic. However, over all three experiments, the variability of the stimulus type estimates was greater than the variability of the stimulus characteristic estimates. These results gave additional support to the hypothesis that the functions were learned cell-by-cell rather than dimension-by-dimension. It was hypothesized that in the posttest phase of all experiments the judgement process used to predict responses to the question in the learning phase would be transferred to a second question to the extent that the two questions were related in the pretest. Though attempts were made to vary the

strength of the pretest relationship by an a priori selection of question pairs, pretest responses to all questions were found to be virtually unrelated to one another. However, in the posttest, the relationships of responses to all question pairs increased, and attained a rank order of strengths originally predicted by the a priori selection of questions. A transfer model, similar to the judgement model tested in Experiments II and III, was proposed to account for this finding.

1974

Armelius, B. A., & Armelius, K. (1974). The use of redundancy in multiple-cue judgments: Data from a suppressor-variable task. American Journal of Psychology, 87(3), 385-392.

Tested the hypothesis that subjects' beta weights tend to match the cue-criterion correlations rather than the cue-criterion beta weights in an experiment on the multiple-cue probability learning of tasks with intercorrelated cues (rij = .00, .40, and .80). Subject were 64 undergraduates. Results support that hypothesis and indicate that subjects were able to utilize the correlations between each cue and the criterion, but not the correlation between cues, as a source of information about the validities of those cues.

Brehmer, B. (1974). The effect of cue intercorrelation on interpersonal learning of probabilistic inference tasks. Organizational Behavior and Human Decision Processes, 12(3), 397-412.

Studied the effects of cue intercorrelation on interpersonal learning of probabilistic inference tasks by means of Hammond's (1972) triple-system lens model paradigm. Using 128 undergraduates, the experiment varied the intercorrelation between two cues, the total predictability of the task, and the distribution of the validities of the cues in a factorial design. In the first blocks, the level of performance was somewhat higher when the cues were intercorrelated, but the intercorrelation did not affect the final level of performance. When task predictability was high, subjects learned the beta weights for the cues, but when task predictability was low, there was no evidence that subjects learned the appropriate weights for the intercorrelated cues. Finally, results show that the policies acquired by the subjects were nonoptimal due to inconsistency. Inconsistency was inversely proportional to task predictability. (21 ref)

Brehmer, B. (1974). Effects of cue validity and task predictability on interpersonal learning of linear inference tasks. Organizational Behavior and Human Decision Processes, 12(1), 17-29.

Conducted an experiment where 32 pairs of undergraduate subjects learned 2-cue linear inference tasks from each other and from the feedback from the task. Results show that (a) Subjects did not develop optimal inference policies, (b) the degree of optimality was inversely related to task predictability, and (c) subjects' performance in tasks which required them to use only one cue did not exceed that in tasks which required them to use two cues. The latter result is interpreted in terms of the subjects' tendency to develop policies in interpersonal learning that served both to increase achievement and to decrease the differences between the judgments made by the subjects in the pair. (20 ref)

Brehmer, B. (1974). Hypotheses about relations between scaled variables in the learning of probabilistic inference tasks. Organizational Behavior and Human Decision

Processes, 11(1), 1-27.
Developed a hypothesis-testing model to account for the effects of the form of the function relating criterion to cue values in the probability learning (CPL) tasks. This model is built on the assumptions that subjects have a hierarchy of hypotheses about functional relations between scaled variables and that they sample hypotheses from the hierarchy according to their strength when learning a CPL task. Five experiments testing the model were conducted with a total of 108 undergraduates and 32 high school students. The first three measured the relative strengths of four specified hypotheses about functional relations by means of estimation and production and showed that a positive linear function is more available than a negative linear function. A -shaped function is the least available. Results of Exp IV, which compared rates of learning for the four functions, showed that the relative rates of learning were consistent with what could be predicted on the basis of the relative strengths of the four hypotheses. In Exp V the subjects' hypothesis-testing behavior was studied by means of verbal reports. Results show that the subjects tested the hypotheses in the order predicted by the hierarchy.

Brehmer, B. (1974). Inductive inferences from uncertain information. Umea Psychological Reports(78).
This paper gives a brief summary Of some of the results from studies on inductive inferences from uncertain information which have been conducted in the tradition Of Brunswik's Probabilistic functionalism and the tradition of decision theory.

Brehmer, B. (1974). Policy conflict and policy change as a function of task characteristics: III. The effects of the distribution of the validities of the cues in the conflict task. Scandinavian Journal of Psychology, 15(2), 135-138.
Used Hammond's interpersonal conflict paradigm in a 2 x 2 design which varied levels of task predictability and levels of cue validity distribution (only one cue valid versus two equally valid cues) with 64 paid undergraduates. Results show that the level of agreement was higher when only one cue was valid than when both cues were valid, but this effect was obtained only when task predictability was high. In the low-predictability condition there were no differences between the two levels of cue validity distribution. Results also show that agreement was a positive function of the predictability of the task. It is concluded that, to understand policy conflict, it is not sufficient to analyze only the characteristics of the parties to the conflict; it is also necessary to analyze the characteristics of the task facing the parties.

Brehmer, B., Kuylenstierna, J., & Liljergren, J. E. (1974). Effects of function form and cue validity on the subjects' hypotheses in probabilistic inference tasks. Organizational Behavior and Human Decision Processes, 11(3), 338-354.
Studied the effects of the form of the function relating criterion values to cue values and of the validity of the cue upon subjects' hypotheses in probabilistic inference tasks in a factorial experiment with two levels of cue validity and four function forms (positive linear, negative linear, inversely U-shaped, and U-shaped). 128 high-school and university students served as subjects. Results are consistent with an hypothesis sampling theory, and the relative frequencies of four basic hypotheses can be predicted from earlier results with respect to the relative strengths of those hypotheses. Results also show that the correlation between the hypotheses stated by subjects and the rules extracted from their judgments by means of polynomial regression was higher for linear hypotheses than for nonlinear. ((c) 1997 APA/PsycINFO, all rights reserved)

Castellan, N. J. (1974). The effect of different types of feedback in multiple-cue

probability learning. Organizational Behavior and Human Decision Processes, 11(1), 44-64.
Required 972 undergraduates to perform a multiple-cue probability learning task with binary cues and binary events. In addition to traditional outcome feedback, subjects were given periodic feedback messages throughout the experiment. Different types of feedback included percentage of correct responses, cue-event validity coefficients, cue-response utilization coefficients, and a combination of the last two types. Feedback was based upon either all previous trials (long-term feedback) or the last 20 trials (short-term feedback) or both. Two different tasks were used. Subjects were assigned to 32 groups in a 4 (feedback type) by 2 (short-term feedback) by 2 (long-term feedback) by 2 (task) design and were individually run for 300 noncontingent trials. Results show that no type of feedback enhanced performance, but all feedback types except percentage correct feedback resulted in a decrement in performance. Long- and short-term feedback interaction effects were found. (19 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

de Klerk, L. F., & Vroon, A. G. (1974). The effect of cue-criterion function form on single-cue learning. Journal of Experimental Psychology, 102(5), 890-892.
Investigated the effect of the form of the function relating cues to a task criterion upon single-cue learning. There were 24 subjects in three groups of eight each. Three function forms were used, one in each condition: a J-shaped, a reversed J-shaped, and a U-shaped function form. Three results emerged. (a) Performance gradually improved with training. (b) A U-shaped function was more difficult to learn than a reversed J-shaped function, and the latter was more difficult than a J-shaped function; this result is in agreement with the progression hypothesis. (c) The relative variances decreased as a function of training; this does not support the two-process theory of single-cue learning, which predicts that the relative variance first decreases and then increases. ((c) 1997 APA/PsycINFO, all rights reserved)

Dudycha, A. L., Dudycha, L. W., & Schmitt, N. W. (1974). Cue redundancy: Some overlooked analytical relationships in MCPL. Organizational Behavior and Human Decision Processes, 11(2), 222-234.
Notes two characteristics of multiple cue probability learning (MCPL) research efforts relating to the manipulation of cue redundancy. First, the fairly prevalent problem of experimental confounding of cue redundancy with other task parameters, and second, the lack of an analytical development of the mathematical relationships among cue validities, task predictability, and regression weights as cue redundancy is varied systematically. Such an analysis is presented, which shows that some of the confounding experienced by earlier researchers may be obviated. ((c) 1997 APA/PsycINFO, all rights reserved)

Lindell, M. K., & Stewart, T. R. (1974). The effects of redundancy in multiple-cue probability learning. American Journal of Psychology, 87(3), 393-398.
Eighty undergraduates had a task of a 2-cue probability learning at a +.8, +.4, .0, -.4, or -.8 level of stimulus redundancy. An analysis of 50 learning trials revealed a significant main effect of Redundancy. Performance was higher when redundancy was lower. Findings are interpreted in terms of task characteristics that accompany redundancy, and the implications for the learning of complex inference tasks are discussed. ((c) 1997 APA/PsycINFO, all rights reserved)

Muchinsky, P. M., & Dudycha, A. L. (1974). The influence of a suppressor variable and labeled stimuli on multiple cue probability learning. Organizational Behavior and Human Decision Processes, 12(3), 429-444.

The effects of a suppressor variable on subjects' achievement, consistency, and matching in a MCPL (multiple-cue probability learning) task were examined at two levels of system predictability; Re = .52 (Exp I) and Re = .92 (Exp II). 200 undergraduates served as subjects. Labeled stimuli were presented in two environments: meaningful and abstract. Three types of control conditions were employed to assess the suppressor effect. Subjects were able to utilize the suppressor effect in making their predictions, but only at the lower level of system predictability involving a meaningful environment. The difficulty of developing a consistent strategy when the meaningfully labeled stimuli were semantically illogical was evidenced. Results are discussed in the framework of Brunswik's (1956) normative model involving meaningful vs abstract decision-making tasks. (28 ref)

Mumpower, J. L., & Hammond, K. R. (1974). Entangled task dimensions: An impediment to interpersonal learning. Organizational Behavior and Human Decision Processes, 11(3), 377-389.

Investigated the effects of intercorrelated task dimensions on interpersonal learning (IPL) in 16 undergraduate subjects. Each subject was trained to use 1 of 2 different judgment policies for a 2-cue probability learning task. Subjects were then paired so that in each pair S1 had been trained to depend in a positive, linear fashion upon one cue and to ignore the other, and S2 had been trained to depend upon the cue S1 ignored and to ignore the cue upon which S1 depended. Each pair then worked together on a task in which they were required to reach a mutually agreeable public judgment on 10 trials. For half of the pairs (Group I) the task-trial cues were highly intercorrelated (+.90): for the other half (Group II) the cues were orthogonal. An interpersonal-prediction task followed. IPL about the Other, as measured by the correlation of one subject's judgments with the other subject's predictions of his judgments, was significantly better for Group II ($p < .001$). Group differences in IPL disappeared after Group I had access to a set of task trials with orthogonal cues. Results demonstrate that IPL is a function of the properties of the task system the subjects encounter, as well as of the properties of the cognitive system the subjects bring to the task.

Norman, K. L. (1974). Rule learning in a stimulus integration task. Journal of Experimental Psychology, 103(5), 941-947.

Studied 40 undergraduates to examine learning of simple linear and configural rules in a stimulus integration task. Subjects learned to produce horizontal motor movements that represented a weighted average biased toward either the shorter or longer distance or the first or second movement in a sequence of two fixed movements. On each trial subjects reported which of the four rules they thought was correct. Results indicate that overall learning rates for the two configural relationships dependent on relative magnitude were slightly superior to those for the two linear relationships dependent on temporal order. Differences in learning were ascribed to a hypothesis-sampling model in which subjects test one mode of bias at a time and learn the form of the rule in an all-or-none manner.

Peters, J. T., Hammond, K. R., & Summers, D. A. (1974). A note on intuitive vs analytic thinking. Organizational Behavior and Human Decision Processes, 12(1), 125-131.

Investigated Brunswik's 1956 propositions concerning intuitive vs analytic thinking by assessing performance of 45 young adult subjects in a 3-cue inference task presented in one of three ways. In Condition 1, cues were presented only as points on a blank, 2-dimensional

field, thus encouraging an intuitive, or perceptual, mode of thinking. In Condition 2, subjects were given only the numerical equivalents of the three cues. In Condition 3, the cues were presented both perceptually and numerically. The resulting error distributions are consistent with Brunswik's theoretical propositions. ((c) 1997 APA/PsycINFO, all rights reserved)

Sheets, C. A., & Miller, M. J. (1974). The effect of cue-criterion function form on multiple-cue probability learning. American Journal of Psychology, 87(4), 629-641.
The effects of positive linear, negative linear, U-shaped, and inverted U-shaped cue-criterion function forms on multiple-cue probability learning were evaluated, and the contribution to achievement of the subject's response consistency, detection of task linearity, and detection of task nonlinearity was explored. Subjects were 80 male undergraduates. Linear relations were learned better than nonlinear relations, owing to more accurate detection of task linearity in linear conditions than detection of task nonlinearity in nonlinear conditions. Further, differential detection of task linearity between subjects in U-shaped and inverted U-shaped conditions suggested that subjects enter a task of multiple-cue probability learning with a positive linear set and thus search for linearity before beginning to detect the nonlinearity in the task. ((c) 1997 APA/PsycINFO, all rights reserved)

Slovic, P. (1974). Hypothesis testing in the learning of positive and negative linear functions. Organizational Behavior and Human Decision Processes, 11(3), 368-376.
83 and 54 paid undergraduates, respectively, in two experiments had to learn to predict a numerical criterion, Y, on the basis of a numerical cue, X. Exp I varied the algebraic sign of rxy and cue-criterion compatibility (similarity) in an attempt to discover why subjects have difficulty learning to use cues that are negatively correlated with a criterion. Compatibility was the major determinant of learning. Exp II showed that learning of negative linear functions was hindered by the presence of intermediate values of X, which were associated with intermediate values of Y. Removal of these intermediate values made the negative linear function much easier to learn. Results are interpreted in terms of the subjects' ability to test hypotheses about functional relationships. ((c) 1997 APA/PsycINFO, all rights reserved)

Steinmann, D. O. (1974). Transfer of lens model training. Organizational Behavior and Human Decision Processes, 12(1), 1-16.
Assessed the effects of training on the ability to learn probabilistic cue-criterion relationships as a function of differential feedback and previous tasks. four paid female undergraduates received outcome feedback (the correct answer), four others received feedforward (statistical information about the task), and eight more received lens model feedback (statistical information about the task and statistical information about performance). Compared with outcome feedback, both feedforward and lens model feedback led to increases in the consistency and knowledge components of accuracy. There was no systematic effect of the eight different tasks on increased effectiveness of feedforward or lens model feedback. Judges who received lens model feedback subsequently used outcome feedback more effectively. The effects of previous tasks on accuracy were due to increases in consistency, and not knowledge. (20 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Stockburger, D. W., & Erickson, J. R. (1974). Probabilistic discrimination learning with dimensionalized stimuli. Organizational Behavior and Human Decision Processes, 11(2), 157-171.
Used two groups of 16 undergraduates each in a probabilistic discrimination experiment where the stimuli contained four binary dimensions and the individual stimuli varied in two values. One group could use either individual cues (dimensions) which varied in their

validity, combinations of cues, or the entire stimulus pattern as the basis of responding, but the other could only use the entire stimulus pattern. The performance of the first group was superior. More detailed examination of the data and fits of several different types of models to the data support the conclusion that subjects in the first group used primarily the single most valid dimension or perhaps the combination of the two most valid dimensions as the basis for responding. An expectancy model presented in 1972 by N. J. Castellan and S. E. Edgell fit the data from both groups quite well. (17 ref)

1975

Armelius, B. A., & Armelius, K. (1975). Integration rules in a multiple-cue probability learning task with intercorrelated cues. Umea Psychological Reports(80).
Studied how subjects use cues in multiple-cue probability learning (MCPL) tasks by having 24 undergraduates complete a questionnaire about how they had made their predictions. The questionnaire was administered after subjects had completed learning of a 2-cue suppressor variable task for 100 trials. For 19 subjects, it was possible to develop three models on the basis of their verbal reports: linear, configural, or estimated weights models. Goodness of fit of the models and the actual responses of the subjects was satisfactory. Ten subjects reached a higher level of performance than expected if they used only the information provided by the cue criterion correlations. Performance was highest for subjects using a linear model, while achievement for subjects using an estimated weights model was low due to low consistency. Performance of subjects using configural models was relatively poor because of the low validity of configural models in the present task. Configural models, however, were as easy to follow as linear models. It is concluded that it is possible to use subjects' verbal reports to study strategies used in MCPL tasks and that it is probably necessary to do so since very different psychological processes may be expressed in the same mathematical model. (16 ref)

Armelius, K., & Armelius, B. A. (1975). Confidence in multiple-cue judgments as a function of cue intercorrelation and task predictability. Umea Psychological Reports(82).
The hypothesis that subjects' confidence is a direct function of the cue intercorrelation rij in a pure judgmental task was tested with 20 undergraduates in a 2-cue multiple-cue probability learning experiment where the cue intercorrelation and total task predictability were inversely related. Results support the hypothesis. When subjects received no feedback, confidence was determined by rij. However, when subjects received feedback the effects of rij on confidence was, as predicted, reduced in the direction of total task predictability.

Armelius, K., & Armelius, B. A. (1975). Detection of cue intercorrelation in multiple-cue probability learning. Umea Psychological Reports(84).
In a study with 82 undergraduates, the detection of cue intercorrelation, rij, was tested in 10 two-cue mcpl tasks after completion of a learning stage. The values of rij ranged from -.80 to .80. The cue-criterion correlations, rei, and the predictability of the tasks, Re2, were factorially combined. Results show a positive linear relation between the subjective and the objective values of rij. The values of rij were, however, underestimated by about 50%. Results are consistent with previous studies on the detection of rij. There was no relation between detection of rij and the performance or any of the task parameters rei or Re2.

Armelius, K., & Armelius, B. A. (1975). Note on detection of cue intercorrelation in multiple-cue probability learning. Scandinavian Journal of Psychology, 16(1), 37-41.

After completion of learning tasks with 2 different levels of cue intercorrelation (rij = .00 and .80), the detection of cue intercorrelation was tested with either a reproduction or a recognition method in a 2 x 2 factorial design. Subjects were 32 undergraduates. The reproduction method yielded an almost perfect matching between the reproduced intercorrelations and the intercorrelations of the tasks, while the recognition method resulted in systematically lower subjective intercorrelations. For the recognition method the subjective intercorrelation varied with the criterion of recognition, so that the stricter the criterion, the higher the subjective intercorrelation.

Armelius, K., & Armelius, B. A. (1975). Note on the effects of cue-criterion correlations, cue intercorrelation and the sign of the cue intercorrelation on confidence in multiple-cue probability learning. Umea Psychological Reports(83).
One hundred undergraduates' confidence in the correctness of their judgments was investigated in a two-cue experiment where the cue-criterion correlations, as well as the sign and magnitude of the intercorrelation between the cues, were systematically varied. Results show that even though subjects' performance was influenced by the task parameters, their confidence was not. Subjects' confidence was low, and there were no differences among conditions. In view of the finding that performance was generally low and that all tasks were considered equally difficult, it is suggested that the 5-point rating scale used to measure confidence was too insensitive and that the criterion for correctness was too strict.

Baranowski, T. (1975). Clinical judgment as a cognitive process: A comparison of linear regression and decision net models. Dissertation Abstracts International, 36(2-B), 930.
The purpose of the present research program was to compare the value of linear and decision net models as process models of human judgment. The linear and decision net models predicated on black box behaviorism and introspectionism, respectively, take differing stands on the complexity of the judgment process and the value of self-report in the study of process. Widely divergent characterizations of the judgment process are obtained from the two models. Two criteria were proposed to analyze the descriptiveness of the process by the model: predictiveness and the enhancement of learning. The first study compared the predictiveness of the two models in a clinical judgment task. The second study used both models as forms of task information in a multiple cue probability learning task. The model which better predicted the judgments, and enhanced the learning process more, was to be considered the more descriptive model of the cognitive judgment process. The overall findings tend to support the decision net as a process model of human judgment. The decision nets significantly outpredicted the linear model in the model development sample. in study one, and consistently, although not significantly outpredict the linear model on crossvalidation. The decision net task information consistently, although not significantly, enhanced judgment learning to a greater extent than did linear model task information, in study two. Three hypotheses, interpreting decision nets as learned rule structures, were supported in study two, providing further support for the decision net as a better process model of human judgment. Unfortunately these tentative findings must be tempered by a host of qualifications. Process tracing in the development of decision net models was not found to be as straightforward a process as indicated in the literature. In fact, the five clinical trainees could not accurately report on their judgment processes. Instead a method was developed which generated stepniods, a special type of decision nets, by imposing an arbitrary structure on the judgments. Thus the use of raw introspection does not seem to be as valuable as might be indicated in the process tracing literature. Furthermore, the

difference in multiple correlations for the linear and decision net models on the crossvalidation sample approached, but was not, significant. In study II, the differences in the uncorrected learning measures may be attributable to the fact that the stepnoids accounted for more of the variance in the judgments than did the linear models. The corrected correlational measure of learning provides no clear support for either model enhancing learning to a greater extent. However, the corrected kappa measures tend to indicate that the participants receiving linear model task information learned to use the nonlinear aspects of the judgments, despite their receiving only linear model task information.

Brehmer, B. (1975). Learning complex rules in probabilistic inference tasks. Umea Psychological Reports(88).

Tested two groups of 10 undergraduates on either of two learning tasks in which the relation between cue and criterion was a J -shaped function and the correlation between cue and criterion was .90. Tasks differed with respect to relative weights for first- and second-degree polynomials. Analysis of verbal hypotheses and two sets of predictions for seven cue values for each group produced strong similarities between groups. Results contradict predictions from Brehmer's hypothesis-sampling model and indicate subjects are indeed capable of learning J -shaped functions. Two possible explanations are suggested: (a) The hypothesis sampling model is correct, and there are J -shaped rules in the subject's hierarchies; earlier studies have not been extensive enough to reveal these. (b) subjects construct hypotheses, rather than sample from a preestablished set of possibilities.

Brehmer, B., Kuylenstierna, J., & Liljergren, J. E. (1975). Effects of information about the probabilistic nature of the task on learning of uncertain inference tasks. Umea Psychological Reports(90).

The effects of information about the probabilistic nature of the task upon the subjects' performance in single-cue probability learning investigated in two experiments. The results indicated that this kind of information is not sufficient to induce optimal performance and there were no differences between groups which where informed about the probabilistic nature of the task and groups which where not so informed with respect to level of performance, number of correct hypotheses, or frequency of hypothesis shifts.

Gillis, J. S. (1975). Effects of Chlorpromazine and Thiothixine on acute schizophrenic patients. In K. R. Hammond & C. R. B. Joyce (Eds.), Psychoactive drugs and social judgment: Theory and research (pp. 109-120): New York: John Wiley and Sons.

19 acute schizophrenics were randomly assigned to three experimental groups: chlorpromazine, thiothixine, or placebo. After 14 days of the drug treatment regimen, subjects participated in two judgment learning tasks (wide-focus and narrow-focus). Achievement (ra) was greatest for the placebo group in both tasks. Although the thiothixine group was more effective than the chlorpromazine group in the narrow-focus task, achievement of the two drug groups were roughly the same, and both were slightly inferior to placebo subjects on the wide focus task. Concerning knowledge (G), placebo subjects performed most effectively and chlorpromazine subject least effectively. These differences were more pronounced in the narrow-focus task. Concerning consistency (Rs), there were essential no differences among the groups on the wide-focus task. On the wide-focus task, placebo subjects were the most consistent and chlorpromazine were the least consistent, with thiothixine subjects between the other two groups.

Gillis, J. S., Stewart, T. R., & Gritz, E. R. (1975). New procedures: Use of interactive computer graphics terminals with psychiatric patients. In K. R. Hammond & C. R. B. Joyce

(Eds.), Psychoactive drugs and social judgment: Theory and research (pp. 217-237): New York: John Wiley and Sons.
Results from the three experiments lead to four primary conclusions: (1) interactive computer graphics techniques can be used with psychopathological populations and with individuals on a variety of chemotherapeutic regimens; (2) these methods appear to be sensitive to drug effects; (3) the type of feedback given, made possible by interactive computer graphics, is as critical for judgmental learning with drug-pathological groups as it is for normal college students; and (4) while both knowledge and control parameters are effected by an individual's drug pathology status, feedback efficacy is primarily a function of the enhanced cognitive control induced by interactive computer graphics presentations. The more general results from this exploratory work with interactive computer graphics are those suggested at the outset of this section. They include the substantive findings that (a) even seriously ill psychiatric patients can be taught to make effective judgments when appropriate means of presenting stimuli and providing feedback are used; (b) type of feedback is critical to such learning; and (c) both knowledge and control parameters are affected. Interactive computer graphics techniques not only appear to facilitate learning, they also appear to be useful in research on the effects of drugs on the cognitive processes of patients.

Gritz, E. R. (1975). Effects of Methylphenidate on mildly depressed hospitalized adults. In K. R. Hammond & C. R. B. Joyce (Eds.), Psychoactive drugs and social judgment: Theory and research (pp. 121-131): New York: John Wiley and Sons.
Twenty-eight patients with a mild depression were randomly assigned to either of two treatment conditions: drug (methyphenidate hydrochloride), or placebo in a double-blind design. Subjects performed a mcpl task with two cues, and received outcome feedback on each of the 60 trial. There was significant learning (achievement, ra), increased knowledge (G) and consistency (Rs) across trials, but there were no significant overall differences in achievement, knowledge, or consistency between groups. There was, however, some indication that methylphenidate linear subjects performed below the level of placebo linear subjects and the methylphenidate nonlinear subjects performed below the other three groups over the first 40 trials. The placebo group appeared to learn more rapidly to use both cues correctly, and reached a higher asymptote, than the drug group.

Hammond, K. R., & Joyce, C. R. B. (Eds.). (1975). Psychoactive drugs and social judgment: Theory and research. New York: John Wiley.
From the book jacket: This book presents new theory and research methods based on 13 systematic interdependent studies by 10 investigators. These studies support the authors' discussion of the deleterious effects of psychoactive drugs on human judgment , interpersonal conflict, and interpersonal learning of both hospitalized patients and normal subjects.

Lichtenstein, S., Earle, T. C., & Slovic, P. (1975). Cue utilization in a numerical prediction task. Journal of Experimental Psychology: Human Perception and Performance, 1(1), 77-85.
Trained 40 male university students to make numerical predictions of a criterion from a cue. Subjects were trained on two separate cues that differed in validity. Later, the cues were presented together, simultaneously for 20 subjects and successively for the rest. Subjects were asked to use both cues to predict the criterion. A regression model provided an adequate fit to the data, and the subjects showed conservatism similar to the conservatism found in previous Bayesian inference studies. However, further analyses showed consistent

deviations from the normative model. The post hoc hypothesis that subjects were regressing each cue, then averaging the regressed values, was supported. Searching for heuristic strategies, rather than relying on the apparent fit of normative models, was advocated. (19 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Miklich, D. R., & Gillis, J. S. (1975). Interaction of age and cue validities in multiple-cue probability learning by children. Psychological Reports, 37(1), 235-240.
Reports two studies which tested the hypothesis that in comparison with older children (early teens) younger children (ages 8-9) would learn multiple-cue probability tasks with equal cue-criterion validities relatively better than tasks with multiple cues and a single cue of high validity. In Study 1, subjects were 39 children assigned to three groups with mean ages of 8.6, 11, and 13.9 yrs. In Study 2, 31 subjects (mean ages 8.1 and 14.3 yrs) were used. The predicted interaction was found in both studies but the pattern differed. This difference was probably due to the variations of the tasks used in the studies. While the age-cue validity interaction is plausible, further research will be required to determine its precise relevance for developmental theory. ((c) 1997 APA/PsycINFO, all rights reserved)

Muchinsky, P. M., & Dudycha, A. L. (1975). Human inference behavior in abstract and meaningful environments. Organizational Behavior and Human Decision Processes, 13(3), 377-391.
Studied the effects of abstract and meaningful environments on a total of 160 undergraduates' achievement, consistency, and matching in a multiple cue probability learning task at two levels of system predictability where re (the multiple correlation between cues and criterion values) was .52 (Exp I) and .92 (Exp II). In the meaningful environment, subjects were instructed to predict a loan applicant's "credit score" from the cues "average monthly debt" and "average number of creditors." In the abstract environment the stimuli were simply referred to as "criterion," "Cue 1," and "Cue 2." Results show that subjects' performance was significantly superior in the meaningful environment, with the exception of consistency in Exp II. Subjects made significantly superior predictions with cues of positive validity in the abstract environment. However, in the meaningful environment, cues of positive and negative validity evoked comparable levels of achievement. (16 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Schmitt, N., & Dudycha, A. L. (1975). Positive and negative cue redundancy in multiple cue probability learning. Memory and Cognition, 3(1), 78-84.
In two separate experiments, 80 undergraduates completed a 2-cue probability learning task in which cue intercorrelation was positive or negative and cue validities were positive or negative. Results indicate that subjects did not learn the negative validity tasks. In addition, there were no significant differences between groups in achievement due to cue intercorrelation in any one experiment. However, the positive redundancy groups were significantly more consistent in the employment of their decision strategy than the negative redundancy groups when cue validities were positive. The negative redundancy groups were superior to positive redundancy groups in matching; again, when cue validities were positive. ((c) 1997 APA/PsycINFO, all rights reserved)

Schmitt, N., & Dudycha, A. L. (1975). A reevaluation of the effect of cue redundancy in multiple-cue probability learning. Journal of Experimental Psychology: Human Learning and Memory, 1(3), 307-315.
Notes that past studies in multiple-cue probability learning have failed to assess adequately the effect of cue intercorrelation, in that the manipulation of the cue intercorrelation factor

has typically resulted in changes in cue validities. In each of the present three experiments with a total of 120 undergraduates, both cue validities and task predictability were held constant while the sign of the cue validities and cue intercorrelation were varied. Results indicate that subjects' achievement in high- and low-intercorrelation conditions was similar- with the exception of Exp I, where task predictability was high (Re2 = .90), and the difference between high and low cue intercorrelation was most pronounced (r12 = .12 vs .95). In this experiment achievement was higher in low-redundancy groups. The expectation that consistency should be higher in redundant conditions was not confirmed; in all three experiments consistency was similar in high- and low-redundancy groups. Because subjects tended to weight cues equally, matching was always less in the low cue-intercorrelation conditions where weighting cues equally resulted in greater disparity between subjects' beta weights and optimal beta weights. Subjects in negative validity conditions were inconsistent and incorrect in their weighting strategies. (21 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Zimbleman, R. (1975). Effects of "street drugs" on young adults. In K. R. Hammond & C. R. B. Joyce (Eds.), Psychoactive drugs and social judgment: Theory and research (pp. 133-145): New York: John Wiley and Sons.

Eighty adult subjects were divided into three groups on the basis on reported drug use: (a) frequent hallucinogenic drug usage, (b) infrequent hallucinogenic drug usage, and (c) nonuse of hallucinogenic drugs. Drug users did not use drugs with 48 hours of experiment participation. Each group learned two 3-cue mcpl tasks (wide-focus and narrow focus) with outcome feedback on every trial. All three groups tended to perform slightly better (higher achievement, ra) on the wide-focus task. Although there were no significant differences in performance between the three groups, infrequent drug users performed slightly better than the drug and nondrug user groups on both tasks.

1976

Almqvist, K., & Brehmer, B. (1976). Effects of alcohol on the learning of linear and nonlinear inference tasks. Umea Psychological Reports(103).

The effects of alcohol on the learning of probabilistic inference tasks was studied in a 2 (levels Of alcohol: no alcohol vs. 2 ml vodka per body weight) by 2 (tasks: linear vs. nonlinear) by 2 (sex of subjects) by 10 (Blocks of trials) factorial experiment. Learning of linear tasks was superior to the learning of nonlinear tasks, but there were no effects of alcohol or sex of subjects on achievements detection of the rule for the task, or consistency in using the rule.

Armelius, B. A., & Armelius, K. (1976). Combination rules in multiple cue probability learning: I. Relation to task characteristics and performance. Umea Psychological Reports(99).

Investigated the rules used by 100 subjects in multiple cue probability learning (MCPL) by verbal reports from subjects after learning a 2-cue MCPL task. Eight tasks varied factorially as to task predictability, cue-criterion correlations, and the sign of the cue intercorrelation. There were also two orthogonal tasks. Of the verbal descriptions given by the 100 subjects, 47 were classified as inconsistent or incomplete, 7 were classified as single rule (i.e., the same rule was used for all cue combinations), and 46 as multiple rules (different rules were used for different parts of the cue matrix). 77% of the 53 combination rules accounted for the systematic variance in subjects' responses. Performance was related to task characteristics

but the frequency of combination rules was not. Subjects with multiple rules performed best, subjects with a single rule the worst. It is concluded that formulating combination rules is important in MCPL performance. (24 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Armelius, B. A., & Armelius, K. (1976). Combination rules in multiple-cue probability learning: II. Performance, confidence and development of rules. Umea Psychological Reports(101).

Studied subjects' use of combination rules in five 2-cue multiple-cue probability learning tasks with varying degrees of predictability. Subjects were asked to state how they made their predictions at different times during the experiment. 70% formulated systematic combination rules, while 30% formulated incomplete or inconsistent rules. About half the rules were "single" with one rule for the complete cue matrix, and about half were "multiple," with different rules for different parts of the matrix. Performance and confidence were higher for subjects who had formulated systematic combination rules. Results are analyzed in terms of a suggested two-stage model for inference behavior. ((c) 1997 APA/PsycINFO, all rights reserved)

Armelius, B. A., & Armelius, K. (1976). Confidence and performance in probabilistic inference tasks with interrelated cues. Umea Psychological Reports(96).

Studied the relation between confidence and 50 undergraduates' beliefs about their performance as well as their actual performance in five 2-cue multiple-cue probability learning (MCPL) tasks. The tasks varied with respect to task predictability. Confidence was strongly related to believed performance but not to actual performance. The lack of relation between believed and actual performance is interpreted as support for the notion that subjects know very little about their performance in MCPL tasks. Confidence was also perfectly related to task predictability, while performance was not. This may in certain tasks cause an illusion of achievement, i.e. subjects feel more confident than their performance allows them to.

Armelius, K., & Armelius, B. A. (1976). The effect of cue-criterion correlations, cue intercorrelations and the sign of the cue intercorrelation on performance in suppressor variable tasks. Organizational Behavior and Human Decision Processes, 17(2), 241-250.

Investigated the performance of 82 undergraduates in a 2-cue multiple-cue probability learning (MCPL) experiment with a 2 x 2 x 2 x 5 factorial design. The difference in total task predictability was due entirely to an increase in the intercorrelation, rij. Effects of total task predictability on performance were therefore interpreted as effects of the cue intercorrelation. Two control conditions, with orthogonal cues and the same values of the cue-criterion correlations as in the experimental conditions, were included in the design. Subjects' consistency was directly related to the cue-criterion correlations, and the cue-judgment beta-weights were directly related to the magnitude of the cue intercorrelation. The sign of rij determined the level of consistency. ((c) 1997 APA/PsycINFO, all rights reserved)

Armelius, K., & Armelius, B. A. (1976). Redundancy and inference behavior. Umea Psychological Reports(102).

In research on multiple-cue probability learning, redundancy has been treated as synonymous with intercorrelation among cues. This definition of redundancy is inadequate, and a definition is proposed based on Brunswik's conceptual framework and similar to the definition used in information theory, i.e., redundancy is the difference between the sum of all squared correlations and the squared multiple correlation; when the intercorrelation between cues does not contribute to the predictable variance in the criterion, the task is

redundant. When the cue intercorrelation does contribute to the predictable variance in the criterion, the task is defined as a suppressor task. Implications for research of this view of probabilistic inference tasks are discussed.

Birnbaum, M. H. (1976). Intuitive numerical prediction. American Journal of Psychology, 89(3), 417-429.

Fifty-three undergraduates were trained, with feedback, to predict a numerical criterion from each of two separate cues and then asked, without feedback, to predict it from a pair of independent cues or a single cue. Their intuitive predictions were qualitatively inconsistent with an additive model, since the effect of one cue varied inversely with the number of cues available, and with a constant-weight averaging model, since the effect of one cue varied inversely with the validity of the other cue. Data are consistent with a relative-weight averaging model, which assumes that subjective cue values are averaged using weights that depend on cue validities. Normative and descriptive theories of intuitive prediction are compared. (17 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B. (1976). Subjects' ability to find the parameters of functional rules in probabilistic inference tasks. Organizational Behavior and Human Decision Processes, 17(2), 388-397.

Subjects' ability to find the parameters for the functional rule relating cue to criterion in probabilistic inference tasks was investigated in a 2 (levels of cue validity: .98 vs .56) by 4 (function forms: positive linear, negative linear, inversely 'U'-shaped, and 'U'-shaped) factorial experiment. Subjects (16 undergraduates) found the mean and standard deviation for the criterion values about equally well for nonlinear and linear functions. The slope of subjects' functions varied with both cue validity and function form, however. In the low cue validity condition, subjects' slopes exceeded those for the task, indicating that subjects did not use the least-squares criterion appropriate for these tasks. The subjective slopes were about equally accurate for all functions in the high validity condition, but in the low validity condition the subjective slopes were more accurate for the nonlinear functions than for the linear functions. (15 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B. (1976). Testing hypotheses about functional relations in probabilistic inference tasks. Umea Psychological Reports(89).

Investigated the ability of 18 paid high school students to test hypotheses about the form of functional relations in probabilistic inference tasks. Two experiments were conducted which varied the functional relation in the task, the hypotheses to be tested, and the validity of the cue. Results show that the subjects used the same amount of information, regardless of the validity of the cue, that nonlinear hypotheses were harder to test accurately than linear hypothesis, and that hypotheses were harder to test when the relation in the task was nonlinear than when it was linear.

Brehmer, B., & Kuylenstierna, J. (1976). Evaluation of performance in the learning of probabilistic inference tasks. Umea Psychological Reports(91).

Earlier studies have shown that giving subjects general information about the nature of probabilistic inference tasks and the strategies required for optimal performance in such tasks has little or no effect on performance. The present experiment tested one possible hypothesis about the reason for the lack of effects in these earlier studies--that subjects are unable to evaluate their performance in an adequate way and that they believe that they can do better than actually allowed by the task. Specifically, the experiment compared conditions where 32 undergraduates were informed about what error to expect if they used the optimal strategy

with conditions where this information was not given. This information did, however, not help the subjects. Instead, those given the information performed less well than subjects not given the information. ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B., Kuylenstierna, J., & Liljergren, J. E. (1976). Task information and performance in probabilistic inference tasks. Umea Psychological Reports(98), 1-9.
Studied performance in single-cue probability learning tasks as a function of the amount of information about the general nature of the probabilistic inference tasks. Four groups of 9 students (about 18 yrs old) were each given different kinds and amounts of information about the probabilistic task. Results show no differences in achievement, number of correct rules, or number of rule shifts among the four levels of task information; the group given no information performed as well as a group informed about the uncertainty in the task and the manner in which this uncertainty should be handled. It is concluded that subjects were unable to assess their performance in statistical terms as required by these kinds of tasks. (15 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B., & Qvarnstrom, G. (1976). Information integration and subjective weights in multiple-cue judgments. Organizational Behavior and Human Decision Processes, 17(1), 118-126.
Used a fictitious medical-diagnosis task to study how subjects integrate information when they do not know the correct integration rule but only the relative weights to be given to the symptoms and the forms of the functions relating the symptoms to the diagnosis. Subjects were 64 undergraduates. Results show (a) that most subjects followed an additive integration rule; (b) that subjects interpreted the weights for a symptom in terms of the slopes of the functions relating the symptoms to the disease, rather than in terms of variance accounted for; and (c) that subjects were less skilled in following nonlinear rules than linear rules. ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B., & Svensson, C. (1976). Learning to use functional rules in inference tasks. Scandinavian Journal of Psychology, 17(4), 313-319.
Earlier studies have established that subjects perform less well in inference tasks with nonlinear rules than in tasks with linear rules and that one source of the lower level of performance in nonlinear tasks is that subjects cannot utilize a nonlinear rule as well as they utilize a linear rule. The present three experiments, with a total of 72 undergraduates, investigated whether utilization of a nonlinear rule can be improved by training. Results show that there was some improvement with training, but the improvement could not be attributed to feedback or to the learning of specific cue and criterion values. Cognitive feedback did not produce higher performance than ordinary outcome feedback. ((c) 1997 APA/PsycINFO, all rights reserved)

Carroll, J. D., & Rosenberg, S. (1976). Learning on a response continuum: Comparison of a linear change and a functional learning model. Journal of Mathematical Psychology, 13, 101-118.
Two reinforcement schedules were used with 80 paid female undergraduates to compare the predictive validity of a linear change model with a functional learning model. In one schedule, termed "convergent," the linear change model predicts convergence to the optimum response, while in the other, termed "divergent," this model predicts that a subject's response will not converge. The functional learning model predicts convergence in both cases. Presence or absence of random error or "noise" in the relationship between response and outcome was varied. In the "noiseless" condition, a subject could discover the optimum

response by chance, so that some subjects could appear to have converged fortuitously. In the "noisy" conditions such chance apparent convergence could not occur. Results did not unequivocally favor either model. While the linear change model's prediction of nonconvergence in the divergent conditions was not sustained, there was a clear difference in speed of convergence, counter to the prediction inferred from the functional learning model. Evidence that at least some subjects were utilizing a functional learning strategy was adduced from the fact that subjects were able to "map out" the relation between response and outcome quite accurately. Data are consistent with a hybrid model assuming a hierarchy of cognitive strategies in which more complex strategies are utilized only when the simpler ones fail to solve the problem. (21 ref)

Estes, W. K. (1976). The cognitive side of probability learning. Psychological Review, 83(1), 37-64.

Models proposed for probability learning largely represent performance rather than learning theory. Perhaps for this reason, quite different models have been required to provide accounts of data arising from different experimental paradigms. In the present approach, a common theoretical framework is sought in concepts of coding and organization in memory. Following the theoretical analysis, an observation-transfer paradigm is developed that permits the study of predictive behavior depending on categorical, as distinguished from episodic, memory. The paradigm was tested in three experiments with 116 subjects: Exp I assessed the effects of variation in both stimulus frequency and outcome probability, Exp II examined the role of stimulus familiarity, and Exp III attempted to vary the encoding of trial outcomes in memory. Results suggest that probability learning and transfer derive from frequency learning. The individual categorizes events and forms representations in memory of relative frequencies of event categories. When different cues in a multiple-cue, probability learning situation occur equally often, this process yields predictive behavior closely reflecting the probabilities that alternative events associated with a cue will occur when the cue is present. But when cue frequencies are unequal, the categorical memory model implies that predictive behavior may be grossly out of line with actual probabilities. In general, depending on task requirements, predictive responses are either direct reflections of relative frequency judgments or are governed by strategies involving an additional level of encoding of event categories. (59 ref)

Holzworth, R. J., & Doherty, M. E. (1976). Feedback effects in a metric multiple-cue probability learning task. Bulletin of the Psychonomic Society, 8(1), 1-3.

In two experiments with a total of 58 undergraduates, three forms of augmented feedback were compared with simple outcome feedback in a computer-run, metric, multiple-cue probability learning task. These included (a) lens model feedback, (b) provision of the predicted criterion value, and (c) provision of categorical information about the criterion. There was significant improvement in performance across six blocks of 25 trials, but no differences among the feedback treatments. In Exp II, two additional groups were run without outcome feedback. These groups received either lens model feedback or predicted criterion feedback. The major result was a sharp increase in consistency, which mediated an increase in achievement, when outcome feedback was not provided.

Lindberg, L. A., & Brehmer, B. (1976). Retroactive interference in single-cue probability learning. Scandinavian Journal of Psychology, 17(1), 35-40.

In a study with 24 high school students, when two single-cue probability learning tasks with

different amounts of unpredictable variance were learned in succession, a low variance task interfered with the retention of a high variance task, but the opposite was not true. The effects were positive in that they enabled subjects to reach a higher response consistency and thus, a higher level of achievement. It is suggested that subjects made use of the low variance task to reject incorrect hypotheses about the cue-criterion relation and that interference from an interpolated task occurs only when this task provides information which has functional value for the S. ((c) 1997 APA/PsycINFO, all rights reserved)

Lindberg, L. A., & Brehmer, B. (1976). Transfer in single-cue probability learning. Organizational Behavior and Human Decision Processes, 16(1), 177-192.

Two experiments investigated transfer in single-cue probability learning as a function of cue validity, using 24 undergraduates in Exp I and 32 high school students in Exp II. Validity was manipulated by means of variation in the unaccounted-for variance in the cue-criterion system. Subjects transferred the systematic aspects of their prediction strategies, as defined by slope of the cue-judgment regression line, in all conditions. With respect to consistency, which was defined in terms of the unaccounted-for variance in the cue-judgment system, direction of change in validity was the important factor. When validity increased, the consistency of the cue-judgment system was transferred, but when validity decreased, relative consistency between both systems was transferred. ((c) 1997 APA/PsycINFO, all rights reserved)

Lindell, M. K. (1976). Cognitive and outcome feedback in multiple-cue probability learning tasks. Journal of Experimental Psychology: Human Learning and Memory, 2(6), 739-745.

Recent research has suggested that outcome feedback is not the optimal form of feedback for learning complex inference tasks. The present experiment was designed to test the effects of outcome feedback against cognitively oriented feedback in a number of linear tasks. The superiority of cognitively oriented feedback, found even in the simpler tasks, is greatest in the most complex task. Implications of these results for both the learning of clinical judgment tasks and interpersonal conflict are noted. (22 ref)

Schmitt, N., Coyle, B. W., & King, L. (1976). Feedback and task predictability as determinants of performance in multiple cue probability learning tasks. Organizational Behavior and Human Decision Processes, 16(2), 388-402.

Several studies conducted within the last decade have suggested that outcome feedback is less than optimal feedback in a multiple-cue probability learning situation. Some of these studies have neglected one or more of the following: a no feedback control group, analysis of the several different types of feedback, assessment of feedback over time, and the effect of feedback on tasks of different difficulty levels. The present two experiments with 160 undergraduates utilized a 2 (outcome feedback) by 2 (cue utilization feedback) by 2 (task information) by 3 (trial blocks) experimental design. It was found that outcome feedback resulted in significantly less consistency, and task information resulted in significantly better matching. Cue utilization feedback enhanced achievement and matching only in combination with task information and only in high predictability tasks. Further research on feedback should focus on feedback and task difficulty interactions as well as the effects of delay of feedback. (20 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Steinmann, D. O. (1976). The effects of cognitive feedback and task complexity in multiple-cue probability learning. Organizational Behavior and Human Decision Processes, 15(2), 168-179.

Twenty-four undergraduates learned three multiple-cue probability learning (mcpl) tasks of varying complexity under conditions of feedforward and cognitive feedback. Statistical information about the task was presented in the feedforward condition; in the cognitive feedback condition, subjects were given statistical information about their own performance in addition to information about the task. Task complexity was manipulated by varying the function forms relating the values of the cues to the values of the criterion: The least complex task contained three positive linear function forms, the intermediate task contained three inverted 'U'-shaped function forms, and there was one negative linear function form, one inverted 'U'-shaped function form, and one 'U'-shaped function form in the most complex task. The hypothesis that cognitive feedback is more effective than feedforward for the more complex task used here was not confirmed. There were no differences between the two groups with regard to achievement, knowledge, or cognitive control. The level of performance on all tasks, including the complex nonlinear tasks, was very higher under both conditions, however, an unexpected finding considered to be important. (29 ref)

1977

Adelman, L. (1977). The effect of formal task properties, forms of feedback, and task content on learning inference tasks. Unpublished doctoral dissertation (DAI, VOL. 37-08B, Page 4209), University of Colorado at Boulder, Department of Psychology.

Empirical research investigating the ability of persons to learn complex inference tasks was reviewed. Research using with meaningless task content indicates that formal task properties (i.e., the relations among task variables) affects participants' overall achievement by affecting knowledge acquisition and/or utilization, and (b) forms of feedback that provide information about formal task properties (e.g., cognitive feedback) lead to higher levels of achievement than that reached with (outcome feedback (i.e., the correct answer). Research using inference tasks with meaningful task content and outcome feedback indicates that (c) task content provides the learner with information about formal task properties, and (d) the more congruent the formal implied by task content and the actual formal task properties, the higher the level of achievement. These conclusions led to the hypothesis that the relative effectiveness of outcome and cognitive feedback to improve achievement depends on the level of task congruence. The results of an experiment support this hypothesis. When information about formal task properties was congruent with actual formal task properties, the level of achievement with outcome feedback was as high as that with cognitive feedback; however, when information about formal task properties was incongruent with actual formal task properties, the level of achievement with cognitive feedback was as low as that with outcome feedback. When steps were taken to ensure a high level of motivation by the participants cognitive feedback led to higher levels of achievement even in the latter case. When task congruence was zero, i.e., when meaningless task content was used, the level of achievement with cognitive feedback was higher than that with outcome feedback, in line with previous research. The implications of these results for learning theory in particular, and for cognitive theory and methodology in general were discussed.

Andersson, H., & Brehmer, B. (1977). Are the policies acquired in interpersonal learning biased? Umea Psychological Reports(120).

Thirty-two undergraduates learned two-cue linear interference tasks with one valid and one nonvalid cue in a two-stage experiment following the "lens model" interpersonal learning

paradigm. In the first stage all subjects learned the task individually from outcome feedback. In the second stage they learned another task under two conditions: interpersonal learning and individual learning, and two task conditions, no change and change. For both learning conditions there was an increased dependency on the nonvalid cue in the no-change condition. Subjects in both conditions thus changed their original policies to the same degree when faced with the second task, thereby using a nonoptimal policy. In the change condition, subjects in both learning conditions learned the second task at the same rate.

Andersson, H., & Brehmer, B. (1977). The effect of having a teacher in an uncertain linear inference task. Umea Psychological Reports(138).

Two hypotheses were tested in a study with 40 high school students: (a) that the presence of a trained subject who could serve as a teacher/partner in a well-defined interpersonal learning situation would have positive effects on the learning of an uncertain linear probabilistic inference task, and (b) that the presence of an untrained subject in an ill-defined situation would have negative effects on learning. Results show that, compared to an individual task-learning control condition, there were no effects of having a teacher in the well-defined case. In the ill-defined situation, however, the presence of the untrained partner had significant negative effects on learning.

Andersson, H., & Brehmer, B. (1977). Inconsistency in interpersonal learning. Umea Psychological Reports(134).

Used the social judgment theory interpersonal learning paradigm to study the effects of four contexts of learning (interpersonal learning, dyadic task-learning, individual task-learning, and individual task-learning with additional information) and two conditions of change (reversal and no change) on 80 undergraduates' ability to learn and use inductive inference policies. A factorial design involving linear 2-cue probability inference tasks with one valid and one invalid cue was employed. Results show that subjects in the reversal change conditions adapted to a new task at a slower rate than subjects in the no-change conditions. This held only in the first block of learning, however. In this respect no difference between contexts of learning was found. Instead there was a trend showing lower consistency for subjects in social learning conditions than for those in individual learning conditions. Possible reasons for the small magnitude of the effects are discussed.

Andersson, H., & Brehmer, B. (1977). Learning linear inference tasks from a "teacher". Umea Psychological Reports(137).

Tested the hypothesis that interpersonal learning of probabilistic inference tasks would be superior to individual learning for tasks with linear cue-criterion relations when subjects are told who has the correct policy and who has not. Data obtained from 40 high school students support the hypothesis. Results suggest that interpersonal learning as studied in the standard social-judgment theory paradigm is a mixture of two processes: interpersonal learning about the other person, and interpersonal learning from the other. The first process may have to precede the second one for subjects to derive any benefits from interpersonal situations.

Andersson, H., & Brehmer, B. (1977). Social facilitation and inhibition in the social judgment theory paradigm. Umea Psychological Reports(132).

Two experiments, each with 24 undergraduates, tested hypotheses derived from Zajonc's (1965) theory about social facilitation and inhibition on interpersonal learning of inductive inference tasks as studied in the social judgment theory research paradigm. Results show no

evidence of social facilitation in a situation where subjects' cognitive systems were relevant to the task, nor of social inhibition in a situation where subjects' had to change their cognitive systems. It is noted that clear evidence of social inhibition and facilitation in earlier studies has been obtained only with simple tasks, and it is therefore concluded that Zajonc's theory may be valid only for tasks involving simple stimulus response connections, but not for complex cognitive tasks.

Andersson, H., & Brehmer, B. (1977). Transfer effects in the SJT interpersonal learning paradigm. Umea Psychological Reports(131).

Conducted an interpersonal learning experiment following the social judgment theory (SJT) paradigm with 32 paid undergraduates. Subjects first learned a 2-cue inference task and were then transferred to a task that was either identical or had reversed cue-criterion correlations. This new task was learned either individually or interpersonally, i.e., in a situation where differently trained subjects were put together. Performance in these conditions was compared to that for subjects learning the transfer task as their first task. Results show that there were no interpersonal effects: subjects learning the new task alone performed as well as those learning it in an interpersonal context. There were positive transfer effects when the second task was identical to the first, indicating that the subjects managed to transfer their policy from the first to the second task. There were negative transfers when cue validities were reversed in the second task. These results show that transfer effects were part of the effects found in the SJT paradigm and that under some circumstances this may be all that is obtained and that no interpersonal learning occurs.

Brehmer, B. (1977). Cognitive skills and optimal performance in judgment tasks. Umea Psychological Reports(107).

This paper summarizes results from a series of studies concerned with the cognitive skills required by inference tasks. Results show that subjects have problems using functional rules, but they are able to use information about the relative weights to be given to the cues in multiple-cue judgment tasks quite well. Training in using functional rules leads to some "warm up" effects, but there seems to be very little genuine improvement. It is argued that lack of cognitive skills is an important factor preventing subjects from performing optimally in judgment tasks and that it also may explain why the correspondence between objective and subjective descriptions of the judgment policies is often found to be low. (17 ref)

Brehmer, B. (1977). General and specific effects of practice in using functional rules in inference tasks. Umea Psychological Reports(114).

Earlier studies have shown that practice in using a given functional rule for making predictions about a criterion from a cue leads to both general and specific effects. Two experimental studies, with 32 undergraduates, tested the hypothesis that the differences between the performance for the trained rule and the transfer rule are due to experiment-specific effects such as "loss of set." The hypothesis was rejected because neither a change in the order of the test tasks, nor an interpolated task, changed performance on the trained rule or the transfer rule.

Brehmer, B. (1977). Learning complex rules in probabilistic inference tasks: III. The effect of cue validity. Umea Psychological Reports(117).

Studied the effect of cue validity on the learning of positive and negative shaped relations in the single-cue probability learning of 32 undergraduates. As would be expected from a hypothesis construction model, learning of the shaped relations was better when cue validity

was high than when it was low. Results also show, however, that positive rules were learned more efficiently than negative rules. This shows that subjects did not construct their hypotheses on the basis of data from task only. It is concluded that subjects construct their hypotheses from elements stored in memory and that data are used only to test their hypotheses.

Brehmer, B., & Almqvist, K. (1977). Effect of alcohol on subjects' ability to use functional rules in inference tasks. Umea Psychological Reports(109).
The effect of alcohol on the ability of 24 undergraduates to use functional rules for making judgments about a criterion variable from a cue variable was studied in an experiment where two factors were systematically varied: alcohol and functional rule. The study employed a 2 (levels of alcohol: no alcohol vs 2 ml of vodka per kg body weight) by 4 (functional rules: positive linear, negative linear, inversely 'U'-shaped, and 'U'-shaped) design. Alcohol led to a lower level of performance for all four rules, suggesting that alcohol has the same effect on cognitive skills as it has on other kinds of skill.

Brehmer, B., & Almqvist, K. (1977). Effects of alcohol in two multiple-cue probability learning tasks. Umea Psychological Reports(108).
The hypothesis that alcohol will affect the learning of tasks that require selective attention was tested in two multiple-cue probability learning experiments employing 64 undergraduates. In Experiment 1, no effect of a dose of 2 ml vodka per kg body weight was found on either a narrow focus task requiring subjects to learn to use one cue and ignore two other cues or on a wide focus task requiring subjects to use all three cues in a 3-cue task. Nor was there any effect of alcohol in Experiment 2, which used only the narrow focus task but where subjects were instructed that only one cue was relevant. Results suggest that the role of attentional processes in multiple-cue probability learning is not well enough understood to use them in investigating drug effects.

Brehmer, B., & Almqvist, P. (1977). Effect of a minimal dose of alcohol on the learning of linear and nonlinear inference tasks (Umea Psychological Reports No. 129): Sweden: University of Umea, Department of Psychology.
A 2 x 2 design was used with 2 alcohol levels (none vs 1 ml/kg of vodka) and 2 learning task levels (simple vs complex) was performed to test the hypothesis that a minimal dosage of alcohol would facilitate the learning of complex tasks. This hypothesis was based on an interpretation of earlier results on the effects of alcohol in terms of a hierarchy of responses. Alcohol is supposed to reduce drive level, and should therefore facilitate the learning of tasks requiring responses low in the hierarchy because a reduction in drive level makes these responses stronger compared to the responses high in the hierarchy. 32 paid undergraduates served as subjects. Results do not support the hypothesis; there were no effects of alcohol on learning.

Brehmer, B., & Almqvist, P. (1977). Learning two multiple-cue probability learning tasks in succession. Umea Psychological Reports(130).
Used 32 undergraduates to study the effects of learning a narrow focus multiple-cue probability learning task (a task in which the subject has to ignore some of the cues) on the learning of a wide focus task (a task in which the subject has to use all the cues) and vice versa. Results show that there were no transfer effects, indicating that both tasks may be given to the same subjects without fear of carryover effects. Results also support an earlier study by the authors in which a strong effect for instructions was obtained only for the narrow focus task.

Brehmer, B., & Johansson, R. (1977). Subjects' ability to use information about cue validity in multiple-cue judgment tasks. Umea Psychological Reports(118).
Subjects' ability to use information about the relative validity of the cues in multiple-cue judgment tasks was investigated in an experiment where 32 undergraduates made judgments about the severity of diseases from two symptoms in fictitious medical tasks. The relative weights given to the symptoms were 2:1, 3:1, 4:1, and 5:1, and subjects gave their response either by using a graphical rating scale or in terms of a number. Results confirm earlier results in showing that subjects interpreted the concept of "weight" in terms of the slopes of the regression lines relating cues and criterion rather than in terms of the variance accounted for by the cues. There were no differences among the four weight ratios with respect to consistency or accuracy of reproduction of the weight ratios.

Brehmer, B., & Kuylenstierna, J. (1977). Content and consistency in multiple-cue probability learning. Umea Psychological Reports(110).
Two experiments employing 24 high school and 16 college students tested the hypothesis that the content of the task will influence subjects' approach to a multiple-cue probability learning task. Results did not support the hypothesis in that they showed that subjects were not more likely to adopt a statistical approach to a task with a content suggesting probabilistic cue-criterion relations than in a task with a content suggesting deterministic cue-criterion relations.

Brehmer, B., & Kuylenstierna, J. (1977). Learning complex rules in probabilistic inference tasks: II. The effect of the postfeedback interval. Umea Psychological Reports(115).
Learning of negative linear and J-shaped cue-criterion relations in single-cue probability learning tasks was studied in an experiment which varied the length of the postfeedback interval. Subjects were 32 undergraduates. Contrary to the predictions from a hypothesis construction model assuming that subjects construct hypotheses from the data provided by the task, there was no effect of the postfeedback interval. Results are interpreted to mean that subjects' constructions are based on elements stored in memory, rather than on data from the task.

Castellan, N. J., & Swaine, M. (1977). Long-term feedback and differential feedback effects in nonmetric multiple-cue probability learning. Behavioral Science, 22(2), 116-128.
Studied the long-term effects of different types of feedback on learning and performance of individual human organisms and the sensitivity of such subjects to changes in the validity of information in probabilistic judgment tasks. The task performed by the 27 female adults consisted of predicting a binary event on the basis of two or three binary cues whose validity changed on each of five successive days. Subjects received one of three different types of informational feedback about their performance--outcome feedback, cue-event validity feedback, or percentage correct feedback. Results indicate, at least for tasks involving additive cues, that adaptation to new cue validities became more rapid on successive days. The different types of feedback tended to produce different response strategies. However, the different strategies had virtually no effect on overall judgmental accuracy. Further, there was an apparent interaction between task characteristics and feedback type. This result is consistent with the results of other studies utilizing differential feedback in similar tasks. (24 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Connolly, T. (1977). Cues, components, and causal structure in laboratory judgment studies. Educational and Psychological Measurement, 37(4), 877-888.

Argues that laboratory studies of judgment in both single- and multiple-cue probability learning paradigms generally ignore the issue of the causal structure underlying the correlations between the cue(s) and the distal variable. The present note stresses that two possible causal structures must be considered: cue-type tasks, in which the stimuli reflect the value of the distal variable; and component-type tasks, in which the stimuli values cause the distal variable value. It is shown that different optimal response strategies can be derived for a given set of cue validities, depending on which causality assumptions are made, and these optimal strategies are derived for the simple cases for n = 1, 2, and 3. Implications for the design and interpretation of laboratory studies are suggested. (25 ref)

Doi, M. (1977). Cue utilization behavior of young children in multiple-cue probability learning. Japanese Journal of Psychology, 48(1), 14-24.

Conducted two experiments based on the multiple-cue probability learning paradigm to study the cue utilization behavior of 6-yr-olds in multidimensional judgment tasks. Subjects were required to use two stimulus dimensions as cues to predict a lever distance that was determined by an experimenter. In Exp I, the effect of dominance on task performance was examined. Results show that the subjects tended to use solely dominant cues for the task, and that performance was a function of the cue validity (cue-criterion correlation) of the dominant cue. In Exp II, subjects' ability to use simultaneously multiple cues corresponding to the cue validity was confirmed, under the optimal condition of cue properties. (35 ref)

Gillis, J. S. (1977). The effects of selected antipsychotic drugs on human judgment. Current Therapeutic Research, 21(2), 224-232.

The effects of three commonly used antipsychotic agents--haloperidol, trifluoperazine, and thioridazine--were evaluated on a series of judgment tasks of graduated complexity. Subjects were 26 25-64 yr old chronic schizophrenic inpatients selected for inclusion in the study on the basis of their present chemotherapeutic regimens. Judgmental performance was evaluated in terms of overall adequacy and its component indices of knowledge and cognitive control. Subjects receiving haloperidol and trifluoperazine were superior to those receiving thioridazine on all indices, these differences being significant on the measure of overall performance. Differences appeared attributable to the inability of thioridazine subjects to make effective use of detailed feedback.

Gillis, J. S., & Davis, H. G. (1977). The effects of Thioridazine and Mesoridazine on the interpersonal learning of acute schizophrenics. Current Therapeutic Research, 21(4), 507-517.

Following a four-week drug-free period, 16 newly hospitalized acute schizophrenics received either thioridazine concentrate or mesoridazine as the besylate concentrate. Starting dose level for thioridazine was 50-200 mg three times/day, and for mesoridazine, 25-50 mg three times/day, dose levels thereafter being determined by subjects' clinical response. After eight weeks on these regimens, subjects completed a series of structured tasks designed to assess their abilities to learn from social interactions. Thioridazine subjects were superior to those receiving mesoridazine on each of the performance indices derived from these tasks. These group differences reached significance on the measure of cognitive control, an index of the subject's ability to maintain a stable approach to cognitive tasks. Implications for the chemotherapy of schizophrenia are considered. (21 ref)

Gillis, J. S., & Parkinson, S. C. (1977). The effects of phenothiazines on complex learning. Current Therapeutic Research, 22(3), 349-355.
Evaluated the effects of four antipsychotic agents--chlorpromazine, trifluoperazine, thioridazine, and fluphenazine decanoate injection--on performance with multiple-cue, probability learning tasks. 32 inpatient schizophrenics (mean age 41 yrs) were selected for inclusion on the basis of their present chemotherapy regimens. Learning was evaluated in terms of overall adequacy and its component indices, knowledge and cognitive control. Subjects receiving fluphenazine injection performed significantly better than those receiving any of the other agents, while there were no differences among the remaining three treatment groups. This pattern was repeated on all indices of task performance. Findings suggest the value of a treatment regimen of fluphenazine injection that will effect symptom alleviation without impairing the patient's learning ability. ((c) 1997 APA/PsycINFO, all rights reserved)

Howson, H. R. (1977). A study of the effects of differential feedback on learning and transfer of a judgmental task. Dissertation Abstracts International, 38(8-A), 4686.
The objective of this research was to investigate the effects of different types of feedback on subject performance in a multiple-cue probabilistic learning task. Analysis of performance was based on the Brunswick lens model of perception. All subjects were initially given complete task instructions using computer-aided instruction (CAI). This was followed by a block of trials in which each subject was given one of three possible types of feedback treatment, no feedback, calculated feedback or probabilistic feedback. A further block of trials was given to each subject in which either a no-feedback or probabilistic-feedback treatment was given. The purpose of this latter block of trials was to investigate the effect of transfer to a different feedback condition. The results confirmed earlier studies indicating that when all subjects were initially given complete task instructions, those receiving probabilistic feedback were adversely affected relative to those subjects receiving no feedback. However the results extended these earlier findings determining that subjects receiving calculated feedback performed significantly better than either no-feedback or probabilistic feedback treatments. The effect of transfer to the no-feedback treatment resulted in improved performance. However the transfer to probabilistic feedback resulted in a significant decrease in performance for subjects initially given the no-feedback treatment. Consequently conclusions concerning the beneficial effect of learning with no feedback, based on previous studies, were qualified. Data were also collected on subjects' perceptions of their accuracy in performing the task. It was found that the transfer to no-feedback treatment adversely affected subjects' perception of accuracy, contrary to the direction of actual performance. Subjects transferring from no feedback to probabilistic feedback perceived their accuracy as increasing, again contrary to actual performance.

Koegel, R. L., & Schreibman, L. (1977). Teaching autistic children to respond to simultaneous multiple cues. Journal of Experimental Child Psychology, 24(2), 299-311.
A number of studies have shown that autistic children tend to learn new discriminations by responding to only a restricted number of available cues and that this may be responsible for some of their abnormal behavior. Therefore, this investigation assessed the feasibility of teaching autistic children to respond to multiple cues. Results show that four autistic children (mean CA, 6 yrs and 9 mo) could learn a conditional discrimination requiring them to discriminate a multiple-cue complex from each of its two component cues. However, the children did not learn this discrimination in the same manner as four normal children. In the early trials, the autistics responded at a higher level to one of the two component cues. Only

after many trials did the autistics respond equally on the basis of both component cues. Results of an initial attempt to teach a general set to respond to multiple cues showed that, when an autistic child was taught a series of successive conditional discriminations, the child eventually learned a set to approach new discriminations by responding equally on the basis of both component cues. Results are discussed in terms of understanding and treating autistic children's abnormal development. (25 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Lindberg, L. A., & Brehmer, B. (1977). Effects of task information and active feedback control in inductive inference. Umea Psychological Reports(123).
Learning of an inductive task with one linear and one quadratic cue was investigated in a 2 (levels of task information: maximum vs minimum) x 2 (control of outcome feedback: active vs passive) x 4 (blocks of trials) factorial experiment using 32 undergraduates. In the maximum information condition subjects were given the criterion distribution, including the mean, for each combination of cue values. In the active feedback condition subjects selected cue combinations and feedback instances in whatever order they wanted. Positive effects of all three factors were obtained with respect to subjects' selection of inference rules and level of task control. It is concluded that subjects' inconsistency under ordinary outcome feedback conditions is due in part to lack of memory capacity and in part to the fact that subjects are prevented from active hypothesis testing. These factors, however, do not fully explain the lack of consistency, as shown by the fact that subjects under the present maximal information/active feedback condition did not reach the maximal level of task control, although they used the optimal inference rules. (19 ref)

Lindberg, L. A., & Brehmer, B. (1977). Progression and hypothesis testing in an inductive inference task. Umea Psychological Reports(121).
The performance of 32 undergraduates in a two-cue inference task was studied in three experiments as a function of relative cue complexity, relative cue validity, task predictability, and cue-criterion function form. Cues were defined through the velocity (more complex) and starting position (less complex) of a moving light spot. While relative cue complexity did not affect performance, the statistical structure of the task determined subjects' relative cue weighting, as well as the final level of task control. Results contradict the progression hypothesis, formulated for perceptual-motor skill development in tracking, and are consistent with earlier studies within the regression-correlation paradigm. (16 ref)

Lindberg, L. A., & Brehmer, B. (1977). Subjects' selection of feedback information in an inductive inference task. Umea Psychological Reports(122).
Thirty-two undergraduates' selection of outcome feedback instances in a probabilistic inference task with 1 linear and 1 nonlinear cue was investigated in a 2 (levels of task information: maximum vs minimum) x 4 (blocks of trials) factorial experiment. Maximal information included the criterion distribution for each cue combination as well as aids for recording feedback instances; minimal information consisted of standard instructions and no memory aids. Under both information conditions, subjects (a) examined one cue at a time, (b) gave priority to the more difficult quadratic cue, and (c) systematically changed their distribution and order of selections as a function of blocks. That is, subjects used the feedback information in a way that is not possible in the standard experimenter-controlled reception paradigm. Furthermore, subjects made consecutive selections of the same cue combination more frequently in the maximum information condition than in the minimum information condition. These results are consistent with the assumptions that subjects under both conditions try to find the functional parameters of the task by means of a hypothesis

testing activity, and that they learn to eliminate incorrect hypotheses with practice.

Norman, K. L. (1977). Hypothesis testing in stimulus integration tasks of varying difficulty. Bulletin of the Psychonomic Society, 9(2), 106-108.
Investigated the processes of hypothesis selection and testing in a simple multiple-cue learning task. Sixty undergraduates learned to predict the numeric value of a criterion on the basis of a set of cues. The criterion was computed as the average of two of the cues plus random error. Following each trial, subjects were asked to select the two cues that they thought were relevant. The number of cues and the predictability of the criterion were varied factorially but, within the limits manipulated, did not affect performance to any appreciable degree. Results suggest that a subjective evaluation function based on the average of pairs of cues was operative and that a cut point was employed to decide whether to maintain or reject the current hypothesis. ((c) 1997 APA/PsycINFO, all rights reserved)

Schmitt, N., Coyle, B. W., & Saari, B. B. (1977). Types of task information feedback in multiple-cue probability learning. Organizational Behavior and Human Decision Processes, 18(2), 316-328.
While it is documented that task information or task information plus subjects' own cue utilization coefficients are superior to outcome feedback in multiple-cue probability learning studies, no attention has been directed to an evaluation of the different possible types of task information that it is possible to give subjects when the task involves dimensions of information that are highly intercorrelated. In the present study with 160 university students, subjects' achievement, consistency, and matching were evaluated in a 2 (outcome feedback vs no outcome feedback) x 4 (no task information; beta weights, beta; zero-order correlations, r; or beta weights times correlations, betar) x 4 (trial blocks) design in which the task involved cues whose beta, r, and betar values indicated different strategies of combination. Results indicate that (a) outcome feedback produced lower consistency but slightly better matching than no outcome feedback, (b) no task information produced matching superior to that of the three treatment groups, and (c) the matching performance of betar conditions was significantly inferior to that of the beta and r conditions. Though performance differences among beta, r, and betar groups were significant, they were very small in correlational terms. It is suggested that future research might focus on the social as opposed to statistical implications of task information feedback and the form in which that feedback is presented. (17 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

1978

Andersson, H. (1978). Studies in interpersonal learning. Umea Psychological Reports Supplement Series(Supplement Number 6).
This dissertation consists of a summary of seven studies on interpersonal learning. The studies reviewed in this summary have shown that old ideas about how subjects learn in a social context are not correct. It have been shown that when subjects are required to learn a task together about which they have no prior knowledge or when they don't know who has the relevant knowledge, it may be very disturbing to have a partner when learning an inductive inference task. This has been demonstrated for linear tasks and, as will be shown in forthcoming reports, it is even more disturbing to have a non-informed partner when the task becomes more complex. Popular ideas about the beneficial effects of solving problems in groups thus seems not to hold for inductive inference tasks (see Kelley & Thibaut, 1969, for a review of results on group problem solving). When on the other hand at least one of the

subjects have relevant knowledge about the task and this is made clear for both subjects in the IPL situation beneficial effects of IPL on the learning can be demonstrated. It is however necessary to make the learning situation well-defined if positive effects of IPL should be obtained. The teaching is however far from optimal also in well-defined learning conditions.

Andersson, H., & Brehmer, B. (1978). Can a person teach all he knows? Evidence from interpersonal learning of inductive inference tasks. Umea Psychological Reports(142).
The hypotheses that interpersonal learning is more effective than individual learning in nonlinear tasks but that students learn relatively less from their teachers when the teachers have to teach a complex nonlinear rule than when they have to teach a simple linear rule was tested in an experiment following the social judgment theory interpersonal learning paradigm. A 2 x 3 x 4 factorial design was employed: (learning tasks: linear vs. nonlinear) by (learning conditions: teachers, who already knew the task, vs. learners, who had to learn the task from the teachers, vs. individual learners, who had to learn the task from outcome feedback from the task) by (blocks of trials). The results supported both hypotheses; the subjects learned the nonlinear task much better in the interpersonal learning conditions than in the individual learning conditions, but for the linear task, there was very little difference between the two learning conditions. Results also indicated that learners approached the same level of performance as their teachers at a slower rate in the nonlinear conditions than in the linear conditions.

Brehmer, B. (1978). Response consistency in probabilistic inference tasks. Organizational Behavior and Human Decision Processes, 22(1), 103-115.
Inconsistency and its relation to task predictability in probabilistic inference tasks was investigated in two experiments with 48 undergraduates. Exp I compared two estimates of consistency, the test-retest reliability and the usual cue-response correlation. These two correlations agreed closely. Exp II studied transfer effects. Subjects were trained on one part of the cue continuum and then tested on the other part. Results showed that inconsistency was the same for both parts of the continuum. The results of these experiments taken together show that inconsistency cannot be explained in terms of recall of feedback values from earlier trials or in terms of systematic deviations from the rule assumed in the analysis. Instead, they indicate that inconsistency is due to lack of reliability in the response system and that reliability is positively related to task predictability. (18 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B., & Kuylenstierna, J. (1978). Task information and performance in probabilistic inference tasks. Organizational Behavior and Human Decision Processes, 22(3), 445-464.
Conducted four experiments with 100 high school students and 32 undergraduates to investigate the effect of various forms of instructions about the nature of the task on optimality in single-cue probability learning tasks. Results show that information about the probabilistic nature of the task did not make subjects adopt statistical strategies, and when they were told to use such strategies, their performance did not improve. Results are interpreted to mean that the metaphor of the subject as an intuitive statistician is misleading, for subjects lack the cognitive capacity needed to implement a statistical strategy. (17 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Edgell, S. E. (1978). Configural information processing in two-cue probability learning. Organizational Behavior and Human Decision Processes, 22(3), 404-416.
Used a linear model transformation technique to reanalyze Edgell and Castellan's (1973)

data. The configural effect reported by those authors was shown to be due completely to a correct utilization by the subjects of the configural information. Further, it was found that any relevant dimensional information was also utilized and that the level of dimensional information utilization was independent of the level of configural information utilization. This analysis technique was also applied to a new experiment with 145 female undergraduates, which showed that this combined dimensional and configural information processing was not due to pattern only processing but rather to mixed processing of both dimensions and patterns. (13 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Nicholson, E. R. (1978). The effects of differential feedback on the performance of multiple cue probability learning tasks by hyperkinetic children. Dissertation Abstracts International, 39(11-A), 6659-6660.

Hyperkinetic male subjects, ages eight to eleven, learned a multiple cue probability learning (MCPL) task under conditions of binary, numerical, or cognitive feedback. Subjects were told either that they were 'right' or 'wrong' in the binary feedback condition; in the numerical condition subjects were told if they were 'right'' or 'wrong'' and the correct answer; in the cognitive feedback condition the subjects were told if they were 'right' or 'wrong'', the correct answer and which cue(s) was or were the most crucial. Task focus was manipulated by varying the cue values; wide focus having two cues of equal value, and narrow focus having two cues, one with a high value and the other a relatively low value. Measures were made for achievement, knowledge and cognitive consistency. The hypothesis that cognitive feedback is more effective than the other types of feedback was confirmed for the acquisition of knowledge (G), for increasing achievement (ra) levels, and for altering cognitive consistency (Rs) but only for subjects performing a narrow focus task. Results were discussed in terms of task focus and selective attention.

Post, P. D. (1978). The cognitive functioning of depressives in a multiple-cue, probabilistic task. Dissertation Abstracts International, 38(10-B), 5040.

This investigation attempted to examine the cognitive functioning of depressives in a multiple-cue probabilistic task. Specifically, the judgments of depressed individuals were studied under situations which incorporated either a high or low degree of task certainty, and a wide or narrow scope of effective cue utilization. In addition, the cognitive flexibility along with the expectancies for success [P(s) estimates] of the depressed subjects were evaluated. Previous research on the cognitive functioning of depressives had suggested that the depressive manifests deficits in the areas of cognitive flexibility and abstraction ability and in tasks requiring effective utilization of multiple information cues. Thus, it was hypothesized that the depressive would manifest achievement (ra) deficits depending, upon particular task conditions. It was also hypothesized that the depressives' expectancies for success in the task would be significantly lower than those of nondepressives, and further that the P(s) estimates would be significantly correlated with success and/or failure in the task. The subjects who participated in this study were students enrolled in Introductory Psychology courses at Texas Tech University. A total of 80 subjects, 40 diagnosed as depressed and 40 as nondepressed, were involved in this experiment. Within a diagnostic category, each subject was randomly assigned to one of four experimental conditions. The four conditions involved variations in the use of a wide or narrow focus of cues, and high or low task certainty. All subjects received outcome feedback on their judgments following each trial. One-half of the subjects received only 40 trials, while the other half (narrow focus groups) participated in the extradimensional shift and received a total of 80 trials. Results

indicate that mildly depressed individuals are able to adequately function in a new and neutral situation. They do, however, manifest a deficit in their ability to consistently apply a particular cognitive strategy to the task, and in their ability to shift their cognitive set to utilize new and more relevant information. In addition, as hypothesized, the depressive had lower probability of success estimates than did the nondepressive. However, the P(s) estimates of either diagnostic group bore no relation to the degree of achievement in the task.

Ruffner, J. W., & Muchinsky, P. M. (1978). The influence of shifting cue validity distributions and group discussion feedback on multiple cue probability learning. Organizational Behavior and Human Decision Processes, 21(2), 189-208.

The effects of group discussion feedback and shifting cue validities on 96 male undergraduates' achievement, consistency, and matching in a multiple cue probability learning task were investigated in a task of constant system predictability. Subjects utilized distributions of meaningfully labeled cues of equal or unequal validity to predict final exam performance. Subjects' performance was examined in two conditions in which a shift in cue validities occurred and in two conditions in which the same validities were employed throughout the task. Feedback from group discussion was provided for half the subjects. Results indicate that subject performance was best when equally valid cues were utilized, especially after an anticipated shift in cue validities. Group discussion feedback facilitated performance only when a shift occurred. Results are discussed in the context of dynamic prediction environments. (28 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Sniezek, J. A., Dudycha, A. L., & Schmitt, N. W. (1978). Learning of negative cue validities as a function of statistical sophistication and instruction. Psychological Reports, 43(3, Pt 2), 1095-1101.

Examined the effects of cue-criterion instructions on subjects' achievement, consistency, and matching. A probability-learning task involving two cues that were negatively related to the criterion was administered to 60 college students who varied in their degree of mathematical training prior to the experiment. On all measures, mathematical sophistication enhanced rate of performance. Increasingly detailed information about cue-criterion relationships and negative linear functions greatly improved level of achievement, demonstrating that subjects can immediately utilize a negative rule if given thorough instruction. Suggestions are made for improving human decision making in probabilistic environments. (13 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Sniezek, J. A., & Naylor, J. C. (1978). Cue measurement scale and functional hypothesis testing in cue probability learning. Organizational Behavior and Human Decision Processes, 22(3), 366-374.

Sniezek's dissertation. Conducted two experiments with 156 college students to investigate hypothesis testing of functional cue-criterion relationships when cue values varied from nominal to interval levels of measurement. Exp I examined subjects' achievement performance with three function forms: positive linear, negative linear, and inverted-U. The effect of the function form manipulation was a higher level of performance with linear functions than with nonlinear functions across all cue scale conditions. While results generally support Brehmer's (1974) hypothesis testing model, they do suggest certain revisions. Exp II employed ecologies with zero system predictability to determine the functional form of subjects' data-independent prediction strategies. Biases in application of various functional rules were apparent only at the interval level of cue measurement. Although subjects' performance at recalling information about prior events was quite high,

they did not optimally utilize this information in the making of decisions. Examination of response interrelationships revealed a number of heuristics. Results are discussed with respect to biases in human statistical intuition, and the nature of cognitive processes underlying judgment. (16 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

1979

Andersson, H., & Brehmer, B. (1979). Note on the policies acquired in interpersonal learning. Organizational Behavior and Human Decision Processes, 24(2), 195-201.
Earlier studies on interpersonal learning have shown that subjects tend to change an optimal policy toward a less optimal one under interpersonal learning conditions. In an experiment reported here, results from the 32 subjects (undergraduates) show that the same kind of change is obtained also in individual learning and that the effect thus is a transfer effect or a regression effect rather than a social effect as was assumed in earlier studies. (8 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Armelius, K. (1979). Task predictability and performance as determinants of confidence in multiple-cue judgments. Scandinavian Journal of Psychology, 20(1), 19-25.
Performed 2 experiments (using 70 undergraduates) to study judges' confidence in their judgments. Exp I showed that judges' confidence is a direct function of the cue intercorrelation, rij, in a pure judgmental task. When judges received feedback, the effect of rij on confidence was, as predicted, reduced. Confidence was, however, systematically related to neither task predictability nor performance in the feedback condition. Exp II was a further study of the effect of feedback on confidence. In addition, the hypothesis that the lack of relation between performance and confidence is due to judges' poor knowledge of how they actually perform in probabilistic inference tasks was tested. The experiment showed that differences among judges' confidence was a direct function of task predictability and that judges' confidence was related to how they believed that they performed rather than to how they actually performed. The theoretical as well as the practical importance of studies of confidence in probabilistic inference tasks is discussed. (12 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B. (1979). Effect of practice on utilization of nonlinear rules in inference tasks. Scandinavian Journal of Psychology, 20(3), 141-149.
The effects of practice on a total of 100 undergraduate subjects' ability to use nonlinear rules were investigated in five experiments. Exp I showed that performance and transfer varied with the amount of practice given. Exp II showed that having to produce overt responses in training did not lead to better performance or transfer. Exps III and IV tested the hypothesis that the low transfer effects were due to interference, but since neither switching the order of test tasks nor an interpolated task affected performance, the hypothesis was rejected. Exp V showed that practice decreased the nonsystematic error in the subjects' response systems but did not affect the systematic features. (10 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B. (1979). Note on hypothesis testing in probabilistic inference tasks. Scandinavian Journal of Psychology, 20(3), 155-158.
Eighteen high school students' ability to test hypotheses about the form of functional relations in probabilistic inference tasks was investigated in two experiments that varied the functional relation in the task, the hypotheses to be tested, and the validity of the cue. Results show that subjects used the same amount of information regardless of the validity of the cue, that nonlinear hypotheses were harder to test accurately than linear hypotheses, and that

hypotheses were harder to test when the relation in the task was nonlinear than when it was linear. (7 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B., & Kuylenstierna, J. (1979). Length of the postfeedback interval and learning of probabilistic inference tasks. Scandinavian Journal of Psychology, 20(3), 151-154.

Learning of negative linear and J-shaped cue-criterion relations in single-cue learning tasks was studied in an experiment, with 32 undergraduate subjects, that varied the length of the postfeedback interval. Contrary to the predictions from a hypothesis construction model assuming that subjects construct hypotheses from the data provided by the task, there was no effect of the postfeedback interval. Results are interpreted to mean that the subjects' constructions are based on elements stored in memory, rather than on data from the task. (9 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Gray, C. W. (1979). Ingredients of intuitive regression. Organizational Behavior and Human Decision Processes, 23(1), 30-48.

Conflicting evidence, mainly from multiple-cue probability learning tasks, leans toward the proposition that people predict uncertain events better than they can express the process that generates them. Since data on that question from single-cue probability learning tasks are almost completely lacking, the experiment attempts to supply it. It used scaled variables in four task validities with positive and negative sign and high and moderate cue-event correlations. Cue weightings inferred from 44 undergraduates' predictions were more accurate than weightings that they made explicit. Brehmer's (1973) findings that rate of learning is affected by factors different from those affecting final level of achievement were confirmed. Overtracking was found, but not as an inverse function of cue validity; previous reports of that finding are challenged. Subjects were more effective in arriving at a predictive scheme that would have worked well if consistently followed than they were in adhering to it. The hypothesis was strengthened that people's effectiveness in predicting uncertain events exceeds their ability to express insight into their prediction process. (28 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Johansson, R., & Brehmer, B. (1979). Inferences from incomplete information: A note. Organizational Behavior and Human Decision Processes, 24(1), 141-145.

Thirty-two high school students learning single-cue probability learning tasks were told that the cue presented to them was only one of the two cues necessary for perfect predictions of the criterion. Because they knew that the information was incomplete, they also knew that there was only a probabilistic relation between the cue and the criterion. Subjects given this information did not, however, perform better than control subjects not given this information, indicating that this way of giving subjects information about the probabilistic nature of the task is no more effective than giving them information that probabilism is an inherent feature of the cue-criterion system, which was done in earlier experiments. (6 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

1980

Alm, H., & Brehmer, B. (1980). Effects of task predictability on subjects' performance and mood in probabilistic inference tasks: A test of Seligman's theory. Umea Psychological Reports(149).

Tested the basic assumption in Seligman's (1975) theory of learned helplessness--that subjects are able to learn when an event is uncontrollable--by using a single-cue probability

learning-task. Results of two experiments with 64 undergraduates show that many subjects were unable to learn that a random task was random. This seemed to be due to their not having an adequate concept of randomness. Practically no helplessness effects were found in the random condition. The effects suggest that a random task induced frustration rather than depression. (12 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B. (1980). Effect of cue validity on learning of complex rules in probabilistic inference tasks. Acta Psychologica, 44(2), 201-210.
Studied the effect of cue validity on the learning of positive and negative J-shaped relations in single-cue probability learning with 32 undergraduates. As would be expected from a hypothesis construction model, learning of the J-shaped relations was better when cue validity was high than when it was low. Results also show that positive J-rules were learned more efficiently than negative J-rules. This showed that subjects did not construct their hypotheses on the basis of data from task only. It is concluded that subjects construct their hypotheses from elements stored in memory and that data are used only to test their hypotheses. (12 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B. (1980). In one word: Not from experience. Acta Psychologica, 45(1-sup-3), 223-241.
Argues that, contrary to general belief, experience has not been shown to improve people's judgments and that this fallacy is based on an incorrect conception of experience. Changing this conception toward Popper's (1963) suggestions about the growth of scientific knowledge should lead to a more realistic but pessimistic view. Studies that evaluate the ability to learn from experience in probabilistic situations are presented to illustrate biases that prevent people from using the information provided by experience; they include use of confirmatory evidence and assumptions about causality and disregard of negative information. (30 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B. (1980). Probabilistic functionalism in the laboratory: Learning and interpersonal (cognitive) conflict. In K. R. Hammond & N. E. Wascoe (Eds.), Realizations of Brunswik's representative design (pp. 13-24): San Francisco: Josey-Bass Inc.
Reviews multiple cue probability learning (mcpl) and interpersonal learning (IPL) laboratory experiments within the framework of Brunswik's probabilistic functionalism (lens model).

Brehmer, B., & Kuylenstierna, J. (1980). Content and consistency in probabilistic inference tasks. Organizational Behavior and Human Decision Processes, 26(1), 54-64.
Four experiments with a total of 24 high school students and 48 undergraduates investigated the relation between content and consistency in multiple-cue probability learning tasks. Exps I and II showed that giving the task a content seen by the subjects as indicating probabilistic cue-criterion relations did not change their general approach to the task; subjects behaved in the same way in these conditions involving no task content. Exps III and IV replicated earlier results from abstract single-cue probability learning tasks, which indicated that giving information about the probabilistic nature of the task and the strategy to use does not lead to better performance. It is concluded that although an inappropriate, deterministic strategy may be the explanation why subjects perform suboptimally in probabilistic inference tasks, changing this strategy to a more appropriate statistical one does not help, presumably because the subjects lack the processing capacity needed to implement this kind of strategy. (7 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B., & Slovic, P. (1980). Information integration in multiple-cue judgments. Journal of Experimental Psychology: Human Perception and Performance, 6(2), 302-308.

Three experiments with 138 undergraduates tested the hypothesis that the strain of integrating information is reduced by treating nonlinear cues as though they were linearly related to the object being judged. The experiments differed with respect to task content, number of cues, and functional relations between cues and judgments. Results do not support the hypothesis: Scale values derived from single stimulus scales did not differ from those obtained with information integration procedures; there were no significant deviations from bilinearity when the cue values were compared across the two scale types. This finding is seen as supporting the assumption in information integration theory that cue values are translated into judgment-relevant subjective values before the integration process. (11 ref)

Edgell, S. E. (1980). Higher order configural information processing in nonmetric multiple-cue probability learning. Organizational Behavior and Human Decision Processes, 25(1), 1-14.

Used 176 female undergraduates to study configural information processing in 3-dimensional nonmetric multiple-cue probability learning environments. Results from three experiments show that subjects did utilize configural information of the overall pattern and subpatterns. Utilization was higher for simpler patterns and for those containing relevant dimensional information. Dimensional information processing was also found and was both stronger than configural information processing and unaffected by the level of configural information utilization. (12 ref)

Edgell, S. E., & Hennessey, J. E. (1980). Irrelevant information and utilization of event base rates in nonmetric multiple-cue probability learning. Organizational Behavior and Human Decision Processes, 26(1), 1-6.

Eighty-four undergraduates were randomly assigned to one of four conditions, which varied according to event base rate (EBR; .7 or .9) and number of irrelevant cues (one or three). The more irrelevant information in the environment, the lower was the subjects' utilization of a moderate EBR. Irrelevant information had little or no effect on the utilization of a high EBR. Results are contrary to predictions of the model proposed by Castellan and Edgell, which predicts no effect of irrelevant information on utilization of an EBR. Present findings are similar to earlier findings for the effect of irrelevant information on the utilization of relevant information.

Fisch, H.-U., Hammond, K. R., Joyce, C. R. B., & O'Reilly, M. (1980). Effects of psychotherapeutic drugs on multiple cue probability learning and retention. Current Therapeutic Research, 28, 34-46.

Antidepressant drugs administered to depressed hospitalized patients were found to differ in their effects on the parameters of a cognitive theory that has also been employed to evaluate judgment processes among normal adults and schizophrenic patients. These results lend support to the potential utility of the theory as a framework for evaluating the effects of psychoactive drugs on the cognitive activity of psychiatric patients, as well as a means for Increasing our understanding of the nature of cognition among normal as well as disturbed human beings.

Gillis, J. S. (1980). Understanding the effects of psychiatric drugs on social judgment. In K. R. Hammond & N. E. Wascoe (Eds.), Realizations of Brunswik's representative design (pp. 25-36): San Francisco: Josey-Bass Inc.

Reviews multiple cue probability learning (MCPL) and interpersonal learning (IPL) laboratory experiments with psychiatric patients. Psychiatric drugs have been found to have

differential effects on MCPL and IPL. Effects are more pronounced in narrow-focus tasks, where some cues are invalid predictors of the criterion variable.

Holzworth, R. J. (1980). Reversal of order of information in a multiple-cue probability learning task. Journal of General Psychology, 102(2), 211-223.
Investigated a modified version of the conventional paradigm employed in research on multiple-cue probability learning. The modified training paradigm, in which the criterion is presented before the cues, was compared with the conventional paradigm, in which the cues are followed by the criterion. A total of 252 undergraduates were tested in three experiments. In Exp I, subjects were required to learn the cue-criterion function form for each of three probabilistic cues. In Exp II, subjects were required to learn validities of the three probabilistic cues. In Exp III, subjects were required to learn cue-criterion function forms and cue validities for either three or five cues. Learning occurred with the presentation of criterion information in each experiment; however, there was no significant difference between training paradigms. (20 ref)

Koele, P. (1980). The influence of labeled stimuli on nonlinear multiple-cue probability learning. Organizational Behavior and Human Decision Processes, 26(1), 22-31.
Multiple-cue probability learning studies show that meaningful cue labeling may lead to an impressive improvement on all achievement indices, especially on subjects' cognitive control. The present study with 60 university students examined whether cue labeling also leads to better task knowledge when nonlinear cue-criterion relations are present. Results indicate that cue labeling only leads to better cognitive control and not to greater task knowledge. However, a postexperimental inquiry showed task knowledge to be superior in the meaningful label conditions. This paradox is explained as either an inability to use manifest knowledge or as a postexperimental sensitization making latent knowledge manifest. (13 ref)

Lindberg, L. A., & Brehmer, B. (1980). Learning a two-cue inference task when one of the cue-criterion relations is known. Scandinavian Journal of Psychology, 21(2), 115-118.
Learning 2-cue probability learning (MPL) tasks when the functional relation between the first cue and the criterion was known to the subject was studied in a factorial experiment with 36 undergraduates. Contrary to the predictions from a hypothesis sampling model assuming independent learning of each cue in MPL, the function form for the first cue was found to affect learning of the second cue, facilitating it when the functional relations were the same for both cues and inhibiting it when the functions were different. Results suggest that it is not possible to extrapolate findings from single-cue probability learning directly to MPL. (8 ref)

Mellers, B. A. (1980). Configurality in multiple-cue probability learning. American Journal of Psychology, 93(3), 429-443.
Ninety-four judges were trained with feedback to predict a numerical criterion from pairs of numerical cues. "Configurality" in the functions relating the cues to the criterion was analyzed by factorially separating forms of additivity and nonadditivity from linearity and nonlinearity. "Configurality" in the judges' responses was decomposed by using graphs of the data to examine systematic discrepancies from feedback values. The subjects' (94 undergraduates) function relating the cues to the criterion was highly dependent on the task function. Judges were able to accurately predict the criterion based on the additive, linear function much sooner than they could with the nonadditive and/or nonlinear functions. However, when the task functions were nonadditive and/or nonlinear, the judges' functions

eventually showed the corresponding task properties. (19 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Sniezek, J. A. (1980). Judgments of probabilistic events: Remembering the past and predicting the future. Journal of Experimental Psychology: Human Perception and Performance, 6(4), 695-706.

Two experiments were conducted with 119 college students to determine the quality of judges' memories of relevant events and how judges use such information in making decisions. Exp I involved a cue probability learning task in which subjects had to recall specific and average past events as well as predict future events. Exp II required estimating means and modes of past events and predicting future events of univariate distributions in which the relationship of these central tendency measures was manipulated. Results indicate that although judges have adequate knowledge about the behavior of events in the past, they do not correctly and consistently apply this knowledge in making decisions about future events. (16 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

1981

Adelman, L. (1981). The influence of formal, substantive, and contextual task properties on the relative effectiveness of different forms of feedback in multiple-cue probability learning tasks. Organizational Behavior and Human Decision Processes, 27(3), 423-442.

Compared the level of achievement reached with cognitive and outcome feedback under three conditions that varied the congruence between task properties implied by task content and actual task properties, using 60 undergraduates. When task content provided no task information, the level of achievement with cognitive feedback was higher than that reached with outcome feedback, even with perfect task predictability. When the task information provided by task content was congruent with actual task properties, however, the level of achievement with outcome feedback was as high as that with cognitive feedback. Two additional experiments with 10 undergraduates showed that the effectiveness of cognitive feedback depended on contextual task properties, such as the number of blocks of trials and the credibility of the feedback. Results indicate that the relative effectiveness of outcome and cognitive feedback depends on formal, substantive, and contextual task properties. (29 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Alm, H., & Brehmer, B. (1981). How subjects explain their failure to learn probabilistic inference tasks. Umea Psychological Reports(158).

Investigated which of the four causal elements--task difficulty, low effort, low ability, and bad luck--32 Swedish undergraduates used to explain their inadequate performance on a single-cue probability learning task. It was found that subjects explained their failure in terms of situational factors. The magnitude of failure had no effect on subjects' attributions for failure, suggesting that subjects in a probabilistic inference task take a deterministic rather than a statistical approach. (9 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Camerer, C. F. (1981). The validity and utility of expert judgment: An empirical developmental approach. Unpublished doctoral dissertation (condensation), University of Chicago.

Extensive research has shown that the predictions of experts are generally no more accurate than simple combinations of quantifiable information; but both experts and laymen maintain belief in the existence of predictive expertise. Three explanations for this apparent paradox

are advanced: (1) The range of tasks documenting the superiority of models over experts is limited. For example, certain tasks may contain cues or interactions which are not specified in judgment models, thereby giving experts a potential predictive advantage over models. More specifically, when disordinal (crossover) interactions exist in data, so that the sign of a given cue-criterion correlation changes with the value of another cue, linear models fit data particularly poorly. If experts can use such patterns in their judgment, they may have a large predictive advantage over linear models. Cue intercorrelation affects the size of disordinal interactions and thus affects the size of experts' potential predictive advantage over models. Experimental data show that subjects can learn to use disordinal interactions in judgment, but only with inconsistency that lowers predictive accuracy. Moreover, experiments show that cue labels, and the knowledge or beliefs they convey, are crucial in enabling subjects to learn disordinal interactions. (2) Cognitive, motivational, and task obstacles often block experts from learning whether their judgments are inaccurate. For instance, when outcomes are causally influenced by actions taken contingent on judgments (e.g., prophecies are self-fulfilling), experts may become overconfident in their predictive abilities. Experimental data tested this hypothesis: Given outcome data in a realistic environment where outcomes were a function of judgments rather than cue values, subjects did become overconfident. Furthermore, subjects used numerous cues and interactions, which were induced from cue labels, and sampling variations, rather than from data. (3) There are many benefits of expertise besides predictive validity of residuals: For instance, expert overconfidence "absorbs uncertainty" about future events, and the ability to "frame" predictions and specify cases effectively is valuable. Since many benefits of expertise are unrelated to residual validity, an emphasis on predictive ability as the sole criterion of expert value may be inadequate.

Dickinson, T. L., & Cooksey, R. W. (1981). MCPL: A program for describing performance in multiple-cue probability learning. Behavior Research Methods, Instruments and Computers, 13(1), 60.

MCPL is a FORTRAN IV program for describing a subject's performance in multiple-cue probability learning. Research on multiple-cue probability learning uses a paradigm based on Brunswik's proposals for investigating cognitive systems. The experimental task requires a subject to utilize multiple cues to make inferences about the values of a learning criterion. On each of several trials, the subject is presented the values of multiple cues, is required to make an inference, and then is shown the value of the criterion. The program can deal with an unlimited number of subjects, but it is restricted to no more than 12 cues, 200 trials, and 12 blocks of trials. However, these restrictions can be modified through minor, internal changes in the program. A source listing with user's instructions and sample input and output can be obtained free of charge by writing Terry L. Dickinson, Department of Psychology, Colorado State University, Fort Collins, Colorado 80523. [Note: Since this article was published in 1981, the program may have undergone revision or may no longer be available. Cooksey is now in Australia.]

Hagafors, R. (1981). Learning of probabilistic inference tasks: The importance of situational variables for the subject-task interaction. Unpublished doctoral dissertation, Sweden: University of Uppsala, Department of Psychology.

Hendrix, W. H., & Dudycha, A. L. (1981). Feedforward and feedback in multiple cue probability learning - facilitating or debilitating? Journal of Experimental Education, 49(3),

137-46.
Abstract: Three levels of feedforward information and five levels of feedback information were administered during a 200 two-cue trial experiment to 150 subjects. The feedforward information consisted of instructions on correlative relationships and cue validities. The feedback information consisted of outcome feedback presented at different rates. Results indicated that: subjects provided with a psychologically relevant MCPL setting with labeled cues can perform at a very high level of proficiency without feedforward or feedback information; statistically naive subjects are unable to use feedforward information to improve their performance; whether subject performance increases or decreases when provided with feedback information depends upon the performance index used; and withdrawal of feedback generally has little effect upon subject performance.

Hoffman, P. J., Earle, T. C., & Slovic, P. (1981). Multidimensional functional learning (MFL) and some new conceptions of feedback. Organizational Behavior and Human Decision Processes, 27(1), 75-102.
MFL was studied by means of a general class of tasks in which a multidimensional stimulus pattern was functionally related to a criterion. 182 subjects learned to predict a numerical criterion value from three numerical cues that varied in importance. In addition to simple outcome feedback, several sophisticated methods of computer-controlled feedback were employed. Results show that a task with nonlinear cue-criterion relationships was not learned by discrete-trial outcome feedback whether or not subjects had active control over the stimulus sequence, and whether or not the cues were varied randomly or systematically over trials. Computer displays showing both the task characteristics and the learner's response characteristics produced effective learning. So did partial differential feedback, a continuous form of feedback in which the stimulus characteristics are controlled by the subject and the numerical criterion is replaced by a tonal frequency. Results suggest that appropriate feedback might enable people to learn far more complex functional relationships than have been thought possible. (26 ref)

Kuylenstierna, J., & Brehmer, B. (1981). Memory aids in the learning of probabilistic inference tasks. Organizational Behavior and Human Decision Processes, 28(3), 415-424.
The effects of memory aids and instructions about the statistical nature of the task and the strategy needed in such a task were studied using a single-cue probability learning task. Although both memory aids and instructions led to somewhat better performance, they did not make subjects (32 high school students) optimal. Subjects did not realize that a linear function was the best rule for the task. Instead they tried more complicated rules, trying to take into account the random fluctuation in the criterion values. This is interpreted as an example of belief in the "law of small numbers." (8 ref)

Naylor, J. C., & Domine, R. K. (1981). Inferences based on uncertain data: Some experiments on the role of slope magnitude, instructions, and stimulus distribution shape on the learning of contingency relationships. Organizational Behavior and Human Decision Processes, 27(1), 1-31.
Subjects' sensitivity with regard to the uncertainty present in single-cue probability learning inference tasks was examined in three experiments with a total of 180 undergraduates. Exp I varied validity sign, validity magnitude, and type of cue marginal (normal, uniform, bimodal). Bimodal distributions tended to be learned most quickly, particularly at low validities, followed by uniform, followed by normal. Uniform conditions, however, tended

to have higher asymptotic residual variance than normal or bimodal conditions. In Exp II, special instructions on the nature of uncertainty relationships were given to subjects. Although performance did improve, subjects did not maximize their behavior. Exp III consisted of two transfer paradigms, from a bimodal to normal distribution and vice versa. Results again indicate that bimodal distributions tended to result in quicker learning of the basic relation (slope), providing greater absolute transfer to test trials than did normal distributions. However, relative (true) transfer affects were highest for normal distribution groups. (34 ref)

Peterson, D. K. (1981). Hypothesis testing in a multiple-cue probability task. Dissertation Abstracts International, 43(5-B).
When making predictions, people typically base their judgments on a number of relevant cues. The multiple-cue probability learning (MCPL) paradigm has been used to study the ability of people to learn the relative importance of cues in making predictions. In the typical MCPL task, subjects are asked to estimate the criterion on the basis of several quantified cues. The actual criterion value is then presented as feedback. The results of previous MCPL studies indicate that people are capable of learning the relative importance of the cues. However, their performance (i.e. predictions) is typically poor because the subjects fail to apply the cue weights consistently. The present study was designed to examine the manner in which subjects learn the importance of the cues. Rather than estimating the criterion directly, subjects in the present study were asked to assign numerical weights to the cues and their estimate of the criterion was calculated from these weights. The results suggest that people attempt to determine the importance of the cues by employing a hypotheses testing approach, comparing their estimate of the criterion to the true criterion value. Only a few of the subjects in the present study were able to improve their estimates of the cue weights. These subjects appeared to use a systematic hypotheses testing approach. That is, they appeared to adjust the weights in gradual increments from one extreme to the other. The majority of subjects, however, used a random approach to testing hypotheses about the cue weights. These subjects showed no improvement in their estimates of the cue weights. The results of the present study therefore, suggest that most people were not capable of learning the importance of the cues.

Shiels, L. (1981). The training of decision makers. Unpublished doctoral dissertation, University of Western Australia.

1982

Alm, H. (1982). Effects of pretraining on the construction of complex rules in probabilistic inference tasks. Umea Psychological Reports(162), 1-13.
Hypothesized that difficulties in learning complex rules in probabilistic inference tasks are associated with limited access to more complex rules. The access variable was manipulated with a pretraining procedure that involved the production of uncommon rules before the learning stage. Subjects were 32 high school and college students. Pretraining had no effect and having the components of a complex rule was a necessary but insufficient condition for construction of a complex rule. It is concluded that learning a complex rule in a probabilistic inference task must be explained in terms of individual differences. (19 ref)

Alm, H. (1982). Learning of probabilistic inference tasks: Effects of uncertainty and function form. Umea Psychological Reports, 9, 1-36.

Examined how people learn to use uncertain information in making judgments. The effects of task predictability and the form of the function relating cue and criterion were studied in four experiments employing cue-probability learning (CPL) tasks. Results show that subjects were not able to cope with tasks concerning randomness and that task predictability affected subjects' mood and functional rules. The form of the hypothesis hierarchy was in general agreement with the earlier results of Brehmer; however, few nonlinear rules were observed, indicating that the proportion of nonlinear rules had been overestimated. It was found that the problem of learning complex rules in CPL tasks may not be a problem of low rule availability and that having the components of a complex rule is a necessary but insufficient condition for construction of a complex rule. (68 ref)

Alm, H., & Brehmer, B. (1982). Hypotheses about cue-criterion relations in linear and random inference tasks. Umea Psychological Reports(164), 1-20.
Assessed 48 undergraduates' hypotheses about cue-criterion relations by means of verbal reports. The notion of learning as a hypotheses-sampling process received considerable support. Results show that (1) subjects used the same hypotheses in both conditions, (2) the hypotheses were few in number, and (3) there was a high degree of resampling of previously discarded hypotheses. The form of the hypothesis hierarchy was in general agreement with Brehmer. Subjects used data from the task mainly to test hypotheses rather than to construct new hypotheses. Subjects behaved in approximately the same way in a random task as in a task in which the validity of the cue was .40. This suggests that there may not be any genuine learning of tasks with low cue validities; "learning" in these tasks is the result of a strong tendency to use linear rules regardless of the nature of the task. (11 ref)

Björkman, M., & Nilsson, R. (1982). Single cue probability learning: Do subjects give priority to small errors or task-regularity? Acta Psychologica, 51(1), 1-11.
In traditional studies of single cue probability learning (SCPL), subjects' errors and the covariation that subjects establish between the judgments and the cue (cue dependency; CD) are confounded. Learning results in increased CD, which is necessarily accompanied by decreasing errors. A method for disentangling errors from CD, which follows standard SCPL-procedure, was tested with 48 subjects by making the criterion contingent on the judgments instead of the cue and by giving standard instructions implying that the cue is informative about the criterion. In this way, errors were controlled independently of any covariation that the subject created between the cue and the judgments and indirectly between the cue and the criterion (task regularity). Whether subjects aimed at small errors or task regularity when the task did not allow them to do both was examined. Results show that error reduction occurred only when task regularity could be maintained. It is concluded that task regularity, and thus CD, has priority to error reduction under the standard conditions used in SCPL experiments. The study was an example of conditions under which a cue illusion (false beliefs in the validity of a cue) arises. (7 p ref)

Cosier, R. A., & Aplin, J. C. (1982). Intuition and decision making: Some empirical evidence. Psychological Reports, 51(1), 275-281.
One hundred and eleven undergraduate business students were separated into high- and low-intuition groups depending on their ability to identify cards before actually seeing them. Subjects then made a series of simulated managerial decisions. Subject in the highly intuitive group performed significantly better than did other subjects. Results suggest that

some individuals may have unique intuitive abilities that may assist in decision making.

Crombe, P. (1982). Apprentissage en situation aleatoire dans le cas d'un ensemble fini de reponses multiples (Probability learning experiment in a discrete case with multiple responses). L'Annee Psychologique, 82(2), 289-305.

When the learning of probabilities was extended to include the continuum case by means of a continuum of responses, the results were somewhat different from these obtained in the discrete case. However, the comparisons were based on results obtained in situations with very limited sets of responses, and the number of events probably altered the adjustment observed in the binary case. It was, therefore, necessary to propose data representative of the probability learning situation in the discrete case while not limiting the experiment to the particular case of a set reduced to two or three elements. The classical situation also had to be extended to a finite set of multiple responses. Twenty subjects were asked to predict the disappearance of one of 24 elements arranged in a circle. The experiment included 360 trials and was run with a unimodal noncontingent reinforcement. The probability distribution was triangular to check the stability of the results previously obtained in the continuum case. Tests specifically related to Markov chains were used to analyze the data. Results do not show any definite difference in behavior as a function of the continuum vs discrete character of the response sets. (21 ref) ((c) 1997 APA/PsycINFO, all rights reserved)

Warg, L.-E., & Brehmer, B. (1982). Both congruent and incongruent task contents facilitate learning of probabilistic inference tasks (Rep. No. 322): Sweden: University of Uppsala, Department of Psychology.

Warg, L.-E., & Brehmer, B. (1982). Effects of feedforward and task content on learning of probabilistic inference tasks (Rep. No. 321): Sweden: University of Uppsala, Department of Psychology.

Zellinger, P. M. (1982). Effects of discussion and type of feedback on group judgments in multiple cue probability learning. Dissertation Abstracts International, 42(11-B), 4609.

The purpose of the research was to examine the effects of different types of feedback and discussion on group judgments in a Multiple Cue Probability Learning (MCPL) task situation. Previous research in MCPL has typically focused upon the individual as the unit of analysis using a variety of task properties as independent variables. Of particular importance has been the question of how various forms of feedback enhance learning. This study explored the impact of three types of feedback, outcome feedback, rank ordered predictors and ecological validity coefficients, and included a no feedback condition, along with discussion and no discussion on group performance. Two of the null hypotheses predicted no differences between the specific types of feedback, while the third null hypothesis predicted no differences between discussion and no discussion. Data were collected during experimental sessions in which groups were asked to make judgments. The sample was composed of 48, three-person groups. Subjects were college freshmen whose participation in one experiment was part of their course requirements. Evaluation of the hypotheses involved a priori comparisons and analyses of variance. Results were mixed. For the dependent variable of achievement, no main effects or interaction effects were found. For the dependent variables of consistency and matching, only a significant main effect was found for type of feedback. In general, the null hypotheses were not rejected. Overall, the major findings were

that no feedback or less detailed feedback was more effective for subject performance than was detailed feedback and that discussion had no effect. The finding that groups who received no feedback occasionally outperformed groups who received some form of feedback was perplexing with potentially significant repercussions for MCPL researchers. Several implications for future MCPL research on groups with discussion and a no feedback (i.e. control) condition were discussed.

1983

Edgell, S. E. (1983). Delayed exposure to configural information in nonmetric multiple-cue probability learning. Organizational Behavior and Human Decision Processes, 32(1), 55-65.
Three groups of undergraduates (N = 56) were run for 480 trials in a 2-cue nonmetric multiple-cue probability learning task. All groups had one relevant cue dimension. One group had no relevant configural information, while another always had relevant configural information. The third group began without relevant configural information and was switched to relevant configural information after Trial 120. The switched group did learn to utilize the configural information but not nearly as strongly as the group that always had relevant configural information. A follow-up study with 100 subjects explored the effects of the length of the delay before exposure to the relevant configural information. Four groups were run under the above conditions but were switched at Trial 40, 80, 120, or 200, respectively. Results replicated the effect for the group switched at Trial 120 and showed no differences among the four groups, indicating that the effect of delayed exposure was constant and required little delay. (34 ref)

Garvill, J., & Garvill, H. (1983). Effects of distribution of cue validities and of feedback on multiple-cue probability judgment in groups. Umea Psychological Reports(165). Ninety-six high school and university students were trained to use one cue in a multiple-cue probability judgment task and were assigned to groups of three each with complementary training. Tasks involved equal or unequal cue validities, and groups received feedback or no feedback. As expected, higher achievement and higher matching were found in the groups working the task with equal cue validity. However, the expected difference in consistency between the feedback and no-feedback conditions was not obtained. Findings are discussed in terms of two types of adjustment processes in groups performing judgment tasks: the subjects' adjustment to each other and the group's adjustment to the task. (16 ref)

Goldsberry, B. S. (1983). In search of the components of task induced judgment decrements (Rep. No. 83-3): Houston: Rice University, Department of Psychology.

Hagafors, R. (1983). Effects of information presentation mode on subjects' hypotheses in a probabilistic inference task. Acta Psychologica, 53(3), 195-204.
Investigated the effects of two modes of information presentation (visual access to an ordered array of cue values vs no access) on 16 subjects' performance in a multiple-cue probability learning (MPL) task. Results indicate that the visual access to an ordered array of cue values led to a larger proportion of correct hypotheses and of optimal selection strategies and to a better learning performance. Results are interpreted as supporting the conjecture that the situational variables may affect the subject's hypotheses about the cue-criterion relations. Results are also discussed with respect to their implications for the theory of MPL. (11 ref)

Hagafors, R., & Brehmer, B. (1983). Does having to justify one's judgments change the nature of the judgment process? Organizational Behavior and Human Decision Processes, 31(2), 223-232.
Investigated the effects of justification on subjects' application of judgment policies in a multiple-cue probability learning task under conditions of high vs low task predictability and provision vs no provision of feedback. Subjects were 64 high school students. Results show that having to justify one's judgments led to higher consistency in the judgment policy when task predictability was low and no feedback was provided. Findings indicate that justification may lead to an analytical mode of functioning in judgment behavior. Implications for research in cognitive conflict are discussed. (12 ref)

1984

Alloy, L. B., & Tabachnik, N. (1984). Assessment of covariation by humans and animals: The joint influence of prior expectations and current situational information. Psychological Review, 91(1), 112-149.
Proposes a theoretical framework for understanding and integrating people's and animals' covariation assessment. It is argued that covariation perception is determined by the interaction between two sources of information: (a) the organism's prior expectations about the covariation between two events and (b) current situational information provided by the environment about the objective contingency between the events. Both accuracies and errors in people's and animals' covariation assessments are analyzed within this interactional theoretical framework. Four lines of research are reviewed in support of this analysis. The issue of accuracy vs rationality in covariation assessment is considered. (8 p ref)

Goldsberry, B. S. (1984). The effects of feedback and predictability on human judgment (Rep. No. 84-3): Houston: Rice University, Department of Psychology.

Gonzalez, M. (1984). Aspects de la representation et experience en situation d'apprentissage predictif: quelques effets sur la validite des jugements. / Task representation and experience in predictive learning: Some effects upon judgmental accuracy. Cahiers de Psychologie Cognitive/Current Psychology of Cognition, 4(4), 363-383.
Investigated the effects of task representation by 160 undergraduates on the accuracy of their judgments in a situation of predictive learning. For each of 160 trials, subjects were presented one of eight cues and predicted one of two possible outcomes giving rise to a feedback. Subjects were assigned to conditions that differed according to prior instructions and mode of responding and were unaware that each outcome was deterministically associated with four of eight cues. The sequence of trials was identical for all subjects. Three aspects of task representation were investigated: the prior information about cue-outcome association, the framing of cues, and the naming of judgment ("guess" or "hit"). Results show that prior biasing information concerning cue-outcome association had a noticeable effect on judgments. Effects of the naming of judgment were also evidenced. (10 ref)

Kerkar, S. P. (1984). Effect of information display format on judgment. Dissertation Abstracts International, 45(4-B).

The multiple regression model has been applied to the study of judgment primarily through the paradigms known as policy capturing and multiple cue probability learning (MCPL). The former involves modeling the way the decision maker weights predictive information; the latter focuses on the process by which the decision maker acquires this strategy. In the first part of the paper, the logic underlying the two approaches is examined, and the research generated by each is discussed. Based on this comparative review, it is argued that neither approach has yet lived up to its potential because each has concentrated too narrowly on particular kinds of issues, at least some of which present serious logical difficulties. Policy capturing, for example, has sought to isolate judgment processes through multiple regression despite the fact that it is logically capable of capturing only predictions. For its part, MCPL research has fallen short by limiting itself to variables suggested by Brunswik's lens model. Better use could be made of the model if it were applied in a more functional manner--one in which it is used to index performance rather than to infer cognitive processes. The functional approach serves as a guiding philosophy for a series of experiments that are described in the second part of the paper. The primary question of interest in these experiments was how the format of displaying visual information affects subsequent judgments and decisions. Two types of displays, numerical and graphical, were investigated using the policy capturing paradigm in the first three experiments and MCPL in the fourth one. The most consistent finding was that subjects' cue weighting differed reliably with type of format. Numerical policies tended to be less precise than graphical ones, but accuracy of predictions did not differ with display. The implications of these findings are discussed both from a practical and theoretical perspective.

Klayman, J. (1984). Learning from feedback in probabilistic environments. Acta Psychologica, 56(1-3), 81-92.

Notes that probability learning studies have documented people's inability to learn probabilistic relationships from outcome feedback. However, the real world is inherently probabilistic, and people are able to develop some understanding of their environment. It is proposed that typical probability learning tasks fail to capture some important learning processes because they focus only on the perception of the shapes and magnitudes of cue-criterion functions and because they have characteristics that encourage an inappropriate deterministic mental set. It is hypothesized that learning in natural environments takes place primarily through the discovery of new valid predictive cues and the incorporation of these new cues into the learner's predictive model. Results of a recent study by Klayman (1983) provide evidence of this model-building process in a suitable experimental setting. It is concluded that model-building processes can elucidate the role of learning from feedback in the development of real-world expertise. (44 ref)

Svenson, O. (1984). A disease named Brunswik's egony: Can verbal reports and a fictitious disease help us understand cognitive processes? Scandinavian Journal of Psychology, 25, 189-191.

Reviews a Ph.D. thesis monograph by G. Ekegren (Verbal reports about strategies in probabilistic inference learning tasks, Acta Universitatis Upsatiensis 8, Uppsala, 1983. ISBN 91-554-1383-8). Imagine that you, in the role of a medical doctor, have to make a prediction of the number of days a patient suffering from Brunswik's egony will have to remain in bed. You have information readily available about the two most important variables for making this prediction, i.e. the patient's blood pressure and his blood sentimentation rate. How

would you proceed in making such a prediction? You do not know about the disease of Brunswik's egony? That does not matter. The subjects investigated in this Ph.D. thesis did not know either. Yet, they provided a lot of valuable information adding to our understanding of cognitive processes when making numerical predictions and how these predictions are changed by experience. It is concluded that Ekegren's monograph describes an interesting series of experiments which shows a gradually increasing sophistication in the collection and analysis of retrospective verbal protocols about cognitive processes. His studies indicate that simultaneous use of regression analyses of numerical judgments and verbal protocols gives us a wider perspective for understanding the parameters of the lens model. Also, Ekegren's studies have shown how difficult it is to interpret think aloud data without a cognitive model which is close to how the subjects themselves represent the structure and the relations of a judgment task. Ekegren's work represents an important contribution to cognitive psychology and as all good research work it opens up a number of new research problems.

Wigton, R. S., Patil, K. D., & Hoellerich, V. L. (1984). Enhanced learning of clinical diagnosis through computer graphics feedback of diagnostic weighting. Proc Annu Conf Res Med Educ, 23, 111-6.

In solving simulated cases where the diagnosis depends on combining several items of clinical information, students given feedback about their diagnostic process improved much faster than students given outcome feedback alone. This result was consistent with Hammond's findings regarding a more abstract task of greater complexity (relationship between cues and outcome was not linear). The improved diagnostic accuracy was accompanied by a closer approximation of student weights to the correct weights. The control groups showed some correction of the weighting used for the most heavily weighted variables but made little change in the weighting of lesser variables, suggesting that the task of adjusting all of these variables may be too complex to achieve from outcome feedback alone. When learning clinical diagnosis, students given feedback about their diagnostic process learned to make the diagnosis more accurately than those given only outcome feedback. It is likely that the potential of computer programs to analyze and provide feedback on the assumptions and weighting used in making judgements will prove a powerful tool in learning medical diagnosis.

1985

Brehmer, B., Alm, H., & Warg, L. E. (1985). Learning and hypothesis testing in probabilistic inference tasks. Scandinavian Journal of Psychology, 26(4), 305-313.

Two studies investigated the relation between learning of probabilistic inference tasks and the availability of correct hypotheses for the tasks in individual subjects. Exp I, with 32 subjects (aged approximately 18 yrs), examined the learning of linear and inversely U-shaped functions. Exp II, with 32 high school and university students, examined the learning of J-shaped functions. Results show that having the correct hypotheses as measured before learning the tasks was neither a sufficient nor a necessary condition for learning the task. It is concluded that the hypothesis measurements are not reliable enough to allow predictions on an individual level and that subjects have not only the four basic functions (i.e., positive linear, negative linear, U-shaped, and inversely U-shaped) in their hypothesis hierarchies but also J-shaped functions. That the subjects can learn such functions is thus no disconfirmation of the hypothesis sampling conception of learning as assumed in earlier studies. (9 ref) ((c)

Cook, P. J., & Schipper, L. M. (1985). Source reliability in a multiple cue probability processing task. Bulletin of the Psychonomic Society, 23(1), 31-34.
Manipulated the reliabilities of information sources concerning two events in a multiple cue probability processing task. Subjects were 20 undergraduates. Five treatments were used in which varying levels of reliability were associated with cues that were of higher or lower probability and were outlier or nonoutlier cues. Different assessments of occurrence of events showed that the reliability of a source of information influenced the subjects' decisions. A cue of high reliability increased preference for that event with which it was associated, whereas a cue of low reliability decreased preference. The strongest preferences occurred when high reliability was associated with a high-probability cue; the weakest preferences occurred when low reliability was associated with a low-probability cue. These results were consistent in each of two replications. Results indicate that subjects did not use a simple averaging strategy, as reported in previous studies. (12 ref)

1986

Arkes, H. R., Dawes, R. M., & Christensen, C. (1986). Factors influencing the use of a decision rule in a probabilistic task. Organizational Behavior and Human Decision Processes, 37(1), 93-110.
Investigated conditions under which subjects would choose not to use a helpful decision rule that would have enabled them to choose correctly on a large proportion (70%) of judgment tasks in two experiments with 268 undergraduates. In Exp I, some subjects were warned that failure to use this rule would probably result in poor performance. Other subjects were either told that 70% was as well as people could do or were encouraged to outperform the rule. This instructional variable was crossed with an incentive manipulation. Subjects were given either cash for each correct judgment, a cash award for being the best judge in their group, or no monetary incentive. Those who were warned about abandoning the rule and those who were given no monetary incentive performed best. Those who were told that 70% was about as well as people could do judged as poorly as those encouraged to outperform the rule. Supplementary analyses indicated that both the warning and lack of incentive led subjects to judge more consistently, while subjects in other conditions changed strategies more frequently after incorrect judgments. Exp II indicated that those who have expertise (or think they have expertise) tend to use a helpful decision rule less than do those with less expertise and consequently do worse. It is suggested that the factors that led subjects to shun the decision rule in these two experiments are present in many important decision-making situations. (34 ref)

Mellers, B. A. (1986). Test of a distributional theory of intuitive numerical prediction. Organizational Behavior and Human Decision Processes, 38(3), 279-294.
Investigated models that describe how subjects combine uncertain information to arrive at an intuitive prediction of a criterion. 71 undergraduates were trained, with feedback, to predict a numerical criterion from each of three single cues. Then they were asked to predict the criterion, without feedback, either from pairs of cues or from single cues. Their predictions were not consistent with a relative weight averaging model, since pairs of cues did not combine additively. The effect of a cue was inversely proportional to the standard deviation of the criterion at each level of the cue. Subjects appeared to apply greater weight to cue

levels with smaller variance (i.e., those cue levels that were more valid). The data could be described by a distributional theory referred to as the equal probability model. For the present experiment, this model implies that the criterion means associated with the levels of each cue are weighted by the reciprocals of the standard deviations and then averaged. Relations between the equal probability model and other models of impression formation are discussed. (35 ref)

Rothstein, H. G. (1986). The effects of time pressure on judgment in multiple cue probability learning. Organizational Behavior and Human Decision Processes, 37(1), 83-92.
Studied the effects of time pressure on judgment using multiple-cue probability learning. 80 undergraduates were trained to use cues with linear or curvilinear function forms to predict a criterion. Subsequent to training, performance under time pressure was compared with self-regulated performance. Lens model analyses indicated that cognitive control deteriorated under time pressure and that cognitive matching remained unchanged. This effect was limited to complex cue-criterion environments containing curvilinear function forms. Results suggest that the time-pressured individual tends to be erratic even while implementing correct policy. (14 ref)

Sniezek, J. A. (1986). The role of variable labels in cue probability learning tasks. Organizational Behavior and Human Decision Processes, 38(2), 141-161.
In two experiments, variable labels were manipulated to produce conditions in which the actual statistical structure was congruent or incongruent with that implied by the labels. In Experiment 1, with 60 undergraduates, the relevant aspect of statistical structure was the relative magnitude of validity of two cues. In Experiment 2, with 89 undergraduates, it was the direction of the slope relating the single cue to the criterion. In terms of task knowledge, congruent labels were better than either incongruent or abstract labels in both tasks, suggesting that congruent labels provide useful information about statistical structure. Prediction consistency with congruent labels was higher than with abstract in both experiments and marginally better than with incongruent labels in Experiment 2. Compared to abstract labels, incongruent labels led to higher consistency in the 2-cue task. In the 1-cue task, both incongruent labels and neutral labels (which have content but do not imply any particular statistical structure) increased task knowledge. A proposed rule selection and formation model attributes the advantages of variable labels to better retrieval, a reduced set of strategies, and modification of interpretations of labels. (26 ref)

Sniezek, J. A., & Reeves, A. P. (1986). Feature cues in probability learning: Data base information and judgment. Organizational Behavior and Human Decision Processes, 37(3), 297-315.
Investigated the impact of summarized historical data, termed a feature cue, on performance in a cue probability learning task. Sixty-four judges (undergraduates) made 150 predictions of a criterion variable (Y(e)) from a single cue variable (X). The feature cue variable (Z) provided subjects with the average past criterion for the cue value on trial i (i.e., the conditional mean Z = Y(e)/X(i)). Availability of the feature cue was varied with an ABA transfer design. Results demonstrate that the presence of the feature cue greatly improved prediction achievement and accuracy. Under certain conditions, consistency and cue weighting were also improved by the feature cue aid. Although the feature cue value itself was not used as a prediction, it served as an anchor around which judgments were dispersed. Implications for decision making with database information are discussed. (24 ref)

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Wigton, R. S., Patil, K. D., & Hoellerich, V. L. (1986). The effect of feedback in learning clinical diagnosis. Journal of Medical Education, 61(10), 816-22.
There is evidence that students who are given information about how they appear to weight information in reaching a judgment can learn to make judgments more accurately. In teaching medical diagnosis, the present authors used a microcomputer system to generate simulated cases and then calculate the relationship between the data presented and the student's diagnosis. Students who were given feedback comparing their apparent weighting of clinical information with the correct weighting learned to diagnose urinary tract infection more accurately than control students who received feedback only on the outcome of their diagnosis.

1987

Björkman, M. (1987). A note on cue probability learning: What conditioning data reveal about cue contrast. Scandinavian Journal of Psychology, 28(3), 226-232.
Demonstrated the existence of a phenomenon called cue contrast, the tendency to infer that the complementary cue indicates the alternative event in a task with 2 cues and 2 events. Previously published data by R. C. Atkinson et al (1959), J. L. Myers and D. Cruse (1968), J. P. Shaffer (1963), and J. Popper and R. C. Atkinson (1958) were used. It is concluded that cue utilization is both an inductive process based on association between cues and events and an inferential process based on contrast. ((c) 1997 APA/PsycINFO, all rights reserved)

Brehmer, B. (1987). Note on subjects' hypotheses in multiple-cue probability learning. Organizational Behavior and Human Decision Processes, 40(3), 323-329.
Studied 32 undergraduates' hypotheses in multiple-cue probability learning by trial-by-trial verbal reports in tasks with linear and nonlinear cue-criterion relations. In accordance with earlier findings, the results show that subjects learned linear tasks rapidly, while nonlinear tasks were not learned at all. Subjects' verbal hypotheses show that they were concerned with rules for combining cue values rather than with cue-criterion functions. Although the subjects seemed to learn multiple-cue tasks through a hypothesis testing process of the same kind as in single-cue probability tasks, the hypotheses tested in multiple-cue tasks were different from those tested in single-cue tasks. ((c) 1997 APA/PsycINFO, all rights reserved)

Edgell, S. E., & Morrissey, J. M. (1987). Delayed exposure to additional relevant information in nonmetric multiple-cue probability learning. Organizational Behavior and Human Decision Processes, 40(1), 22-38.
Investigated the effect of additional information becoming relevant during the course of learning trials in nonmetric multiple-cue probability learning, using five experiments with a total of 446 undergraduates. Results show that utilization of configural information was degraded when the information became relevant during learning in an environment with a relevant dimension compared with the level of utilization if the information was relevant to begin with. The amount of degradation was again found to be constant regardless of the length of delay in introducing the relevant configural information. Some degradation was found for the utilization of dimensional information that became relevant during learning in an environment with relevant information in the other dimension. The longer the delay, the greater the degradation. ((c) 1997 APA/PsycINFO, all rights reserved)

Kamouri, J. (1987). Passive versus active information retrieval: The effects on multiple cue probability learning in the presence of irrelevant cues. Dissertation Abstracts

International, 47(11-B), 4688.
The present study examined the effects of three methods of retrieving profiles from a simulated information system on learning cue-criterion relationships in two experiments. The information system contained profiles that represented data about either three or four actions a manager could take to increase business (cues) and subsequent changes in the number of customer orders (criterion). Each profile contained a criterion value and values for two relevant cues and either one (Experiment 1) or two (Experiment 2) irrelevant cues. Subjects either observed profiles presented to them in a predetermined order (passive group), or actively retrieved profiles by selecting specific cue values (cue-based sampling group) or criterion values (criterion-based sampling group). Knowledge of cue-criterion relationships was assessed by having subjects rate the relative importance of the cues they had reviewed in the profiles, and then predict, on a number of additional trials, the criterion value they would expect to be associated with specific cue values. In the first experiment, the correspondence between each subject's predictions (achievement) and the consistency with which those predictions were made were significantly greater in the passive group than in the cue-based sampling group, for which achievement and consistency were, in turn, significantly greater than in the criterion-based sampling group. Moreover, knowledge of cue-criterion relationships (matching) was significantly greater in the passive and cue-based sampling groups than in the criterion-based sampling groups. Similar results were obtained when an additional irrelevant cue was added in the second experiment. These results suggest that the way in which data are retrieved can affect one's knowledge of the relationships between the variables in those data.

Meyer, R. J. (1987). The learning of multiattribute judgment policies. Journal of Consumer Research, 14(2), 155-173.
One hundred and seventy-six subjects were asked to learn inductively a multiattribute rule defining product quality in a novel category. Subjects in Exp I were capable of predicting outcomes of a single multiattribute rule with only four feedback bits, the primary evaluation method being comparisons to examples. There was bias in these judgments; subjects were able to learn attributes associated with a good option more rapidly and accurately than those associated with a bad one. Exp II reinforced these results. In addition, the ability to learn rules was largely independent of the degree to which subjects could control their method of learning, and subjects used configural judgment policies to arrive at predictions even when the true generating rule was additive in nature. ((c) 1997 APA/PsycINFO, all rights reserved)

Wigton, R. S. (1987). The use of computer simulation in teaching clinical diagnosis. Comput Methods Programs Biomed, 25(2), 111-4.
Previous studies have shown that feedback of the weighting used in making complex judgements can greatly improve learning when the correct weighting is known. This paper describes the application to teaching medical diagnosis of a microcomputer program which calculates and displays factor weighting based on answers to clinical case simulations. In one application, students learning to diagnose urinary tract infusion with computer feedback of weighting progressed much more rapidly than a control group who received outcome feedback alone. Other applications in the clinical setting suggest that this type of learning can improve diagnostic accuracy and predictive calibration through more accurate assimilation of the clinical information available.

York, K. M., Doherty, M. E., & Kamouri, J. (1987). The influence of cue unreliability on judgment in a multiple cue probability learning task. Organizational Behavior and Human

Decision Processes, 39(3), 303-317.
Tested the effect of cue reliability in 42 undergraduates, using a 2-cue multiple-cue probability learning task. Unreliability in a cue was defined as variability in multiple observations of that cue on a given trial; that variability was provided by adding random errors to the true value of the cue. Subjects were randomly assigned to three groups: One group was given consistent cues (i.e., the more valid cue was the more reliable cue); one group was given inconsistent cues; and the control group was given true scores. Cue reliability did not affect subjects' consistency or achievement but did interact with the presence of outcome feedback. The subjective weights showed that subjects thought they weighted the more reliable cue more heavily regardless of the cue validities or their actual cue weightings. ((c) 1997 APA/PsycINFO, all rights reserved)

1988

Doherty, M. E., & Balzer, W. K. (1988). Cognitive feedback. In B. Brehmer & C. R. B. Joyce (Eds.), Human judgment: The SJT view. Advances in psychology (pp. 163-197): Amsterdam, Netherlands: North Holland.
Reviews research on cognitive feedback. This chapter led to a review article in Psychological Bulletin by Balzer, Doherty, and O'Connor (1989). Cognitive feedback (CFB) refers to the process of presenting the person information about the relations in the environment (task information, TI), relations perceived by the person (cognitive information, CI), and relations between the environment and the person's perceptions of the environment (functional validity information, FVI). Overall, CFB does improve performance on judgment tasks. Research indicates that TI rather than CI is the aspect of CFB that influences performance. CFB is discussed in relation to Cognitive Continuum Theory (CCT). Potential applications of CFB are explored.

Klayman, J. (1988). Cue discovery in probabilistic environments: Uncertainty and experimentation. Journal of Experimental Psychology: Learning, Memory, and Cognition, 14(2), 317-330.
It is argued that cue discovery is an important part of the task of learning from experience in probabilistic environments. Cue discovery involves the identification of new valid predictive cues, and their incorporation into the learner's mental model. In contrast, previous work in "multiple-cue probability learning" has focused principally on learning the quantitative characteristics of given cue-criterion relations. In two studies presented here, 36 college students learned to predict the behavior of a computer-controlled graphic display. The criterion behavior was a function of four to six cues, including several not explicitly identified. Analyses of test results, verbal reports, and behavior during learning indicate that subjects used outcome feedback to accomplish cue discovery. This process was accomplished more effectively when subjects were permitted to experiment by designing their own learning experiences. A distinction is drawn between a system whose behavior is unpredictable because of the presence of unknown controlling variables, and one that contains "random" error. Cue discovery may be more difficult in the latter case, but is accomplished nonetheless. ((c) 1997 APA/PsycINFO, all rights reserved)

Klayman, J. (1988). On the how and why (not) of learning from outcomes. In B. Brehmer & C. R. B. Joyce (Eds.), Human judgment: The SJT view (pp. 115 162): Amsterdam, Netherlands: North Holland.
(from the chapter) learning in the laboratory: the cue-learning approach /// learning function

forms / learning weights and combination rules /// learning from real experience: studies of experienced judges /// limitations of the MCPL [multiple cue probability learning] tradition /// inside MCPL: hypotheses and knowledge in learning from feedback /// beyond MCPL: new domains of cue learning /// cue learning in the big picture of learning.
Cue learning captures a type of learning with great ecological importance: the ability to use feedback to develop mental models for predicting, explaining, and controlling the environment, based on multiple, indirect, imperfect cues. Research has shown this kind of learning cannot be taken for granted as part of human mental ability. It is in fact an amalgam of different judgment tasks, constrained by the limits of human cognitive capacities. After 30 years though, the paradigm is showing signs of wear. Many cue-learning studies articles refer circularly to each other and not much else. … On the other hand, a variety of interesting and significant research can be found just a few steps off the well-worn path of mainstream, paradigmatic MCPL research. Considering these slightly off-center lines of research produce a more vital and varied picture of the questions (e.g., what are the subjects' hypotheses?), techniques (e.g., verbal protocol analysis), and domains (e.g., dynamic learning tasks) of cue learning research. … in addition to expanding the picture of what cue learning has been about, these promise to be among the liveliest topics for future research in the area. (pp. 149-150)

Sniezek, J. A. (1988). Prediction with single event versus aggregate data. Organizational Behavior and Human Decision Processes, 41(2), 196-210.
Studied the impact of statistical information on the predictive judgment of 84 undergraduates in a feature cue (Z) probability learning task. Two kinds of aggregate information about criterion events were used: the conditional mean (Z(m)) and the conditional interquartile range (Z(r)). The single event information was the exact criterion value for one randomly selected past case (Z(o)). Results show that Z(m) and Z(r) increased prediction consistency and accuracy and reduced bias while Z-sub(o) led to more appropriate cue weighting but lower consistency and accuracy. When Z(m), Z(r), and Z(o) were all provided, the unique benefits of single-event and aggregate data were combined. Judges most often chose aggregate information, but the statistical information was still underutilized. ((c) 1997 APA/PsycINFO, all rights reserved)

Wigton, R. S. (1988). Applications of judgment analysis and cognitive feedback to medicine. In B. Brehmer & C. R. B. Joyce (Eds.), Human judgment: The SJT view (pp. 227-245): Amsterdam, Netherlands: North-Holland.
(from the chapter) describe some of the striking results of application of SJT [social judgment theory] to medical judgment /// variation among medical experts /// identification of important clinical variables /// contrasting self described strategies with those derived from paper cases /// comparison of physicians' policies with patient data /// application of cognitive feedback to medicine.

1989

Balzer, W. K., Doherty, M. E., & O'Connor, R. (1989). Effects of cognitive feedback on performance. Psychological Bulletin, 106(3), 410-433.
This presents a comprehensive review of the empirical literature bearing on the effects of cognitive feedback (CFB) on multiple measures of performance. CFB refers to the process of presenting the person information about the relations in the environment (task information [TI]), relations perceived by the person (cognitive information [CI]), and relations between

the environment and the person's perceptions of the environment (functional validity information [FVI]). Overall, CFB does improve performance on judgment tasks. Specifically, the research indicates that TI rather than CI is the aspect of CFB that influences performance. Factors influencing the effects of CFB on performance are discussed, and both current and potential applications of CFB are explored.

Doherty, M. E., & Sullivan, J. A. (1989). r = p. Organizational Behavior and Human Decision Processes, 43, 136-144.

Discusses measurement error in the environment, specifically a form of error in which, on some proportion of trials, the obtained measurement is completely unrelated to what is supposedly being measured. This form of error, defined and labeled herein as system failure (SF) error, has not been commonly studied in investigations of probabilistic environments. An application of the Pearson product moment correlation is suggested as a means of making experimental environments with SF error partly commensurable with those in which error is traditionally manipulated. The relation between the proportion of SF errors and rho is shown for a bivariate case and for a simple multivariate case. Monte Carlo estimates of the sampling distribution of r in environments with SF error are provided for 4 levels of SF error for one example of a experimental environment.

Earley, P. C., Connolly, T., & Ekegren, G. (1989). Goals, strategy development, and task performance: Some limits on the efficacy of goal setting. Journal of Applied Psychology, 74(1), 24-33.

Specific, difficult goals enhance performance in many tasks. We hypothesize, however, that this effect disappears or reverses for novel tasks that allow multiple alternative strategies. We report findings from three laboratory experiments using a stock market prediction task with these characteristics. In the first study, 34 students made predictions concerning the value of 100 companies' stock based on three manipulated cues after receiving either a "do your best" or a specific, difficult goal concerning the accuracy of their predictions. In the second study, 88 students making stock market predictions received one of the following goals: do your best, specific-easy, specific-moderate, specific-hard, or a tapering, specific goal. The third study (n = 30) replicated the first study by using a different prediction algorithm for the stock market simulation. Repeated measures multivariate analyses of variance conducted on indexes of prediction accuracy and predictor weightings supported the hypothesis that specific, difficult goals (prediction accuracy) increase an individual's strategy search activity and reduce prediction accuracy for the stock predictions.

O'Connor, R. M., Doherty, M. E., & Tweney, R. D. (1989). The effects of system failure error on predictions. Organizational Behavior and Human Decision Processes, 44(1), 1-11.

Thirty introductory psychology students participated in a 2-cue multiple-cue probability learning experiment in which there were multiple observations on each cue on each trial; these observations made the data error, or ecological unreliability (E. Brunswik, 1956), highly salient. In one condition both cues were degraded only by measurement error (ME), i.e., the five observations varied randomly around the true cue value. In the second condition both cues were degraded by ME, while one of the two cues was also degraded by a form of error called system failure (SF) error on 30% of the trials. SF error refers to the form of error associated with technological rather than biological systems, in that any given observation may be irrelevant to what is to be measured. The SF condition was significantly more

predictable than the ME only condition, yet subjects had significantly lower achievement. ((c) 1997 APA/PsycINFO, all rights reserved)

1990

Ruble, T. L., & Cosier, R. A. (1990). Effects of cognitive styles and decision setting on performance. Organizational Behavior and Human Decision Processes, 46(2), 283-295.
Examined the effects of cognitive style and decision setting on prediction accuracy in the multiple-cue probability learning paradigm, which is based on Brunswik's lens model. Subjects were 162 upper-division business students. Cognitive style was measured by the Myers-Briggs Type Indicator. Decision setting was manipulated by varying sets of meaningful cue labels. Results indicate that task differences (decision settings) affected prediction accuracy. However, no main or interaction effects of cognitive styles on performance were found. ((c) 1997 APA/PsycINFO, all rights reserved)

Sawyer, J. E. (1990). Effects of risk and ambiguity on judgments of contingency relations and behavioral resource allocation decisions. Organizational Behavior and Human Decision Processes, 45(1), 85-110.
Naylor, Pritchard, and Ilgen (1980) hypothesized that, once a person makes a judgment of a contingency function, that person allocates time and effort in accordance with that judgment. The effects of risk and ambiguity on judgments of the function form and on allocation decisions related to the judged function forms were examined using a 2 X 2 design with each of 2 function forms. A total of 247 introductory psychology students participated in the experiment. Each subject learned two cue-criterion functions through cue probability learning tasks. When the two functions were learned under different conditions, the subjects erred in the direction of allocating more resources to the function learned under less uncertain conditions. The failure to match the optimal allocation rule was not random error but systematic bias.

Wigton, R. S., Poses, R. M., Collins, M., & Cebul, R. D. (1990). Teaching old dogs new tricks: Using cognitive feedback to improve physicians' diagnostic judgments on simulated cases. Academic Medicine, 65(9, Suppl), S5-S6.
Conducted a controlled trial of an educational intervention using computer-simulated cases of pharyngitis patients to improve the diagnostic accuracy of 11 experienced student-health physicians. Three computer-based cognitive feedback sessions were given at 1, 3, and 6 months following an initial lecture. Subjects estimated the probability of a positive culture for each case. After reviewing the feedback, subjects continued with a second set of cases with feedback after each set. During the 6 month intervention, subjects' judgments about simulated patients became better calibrated and more closely matched to those made by the lens model. A similar study with 12 second-year medical students found similar results. Computer-based cognitive feedback seems to be an effective method for improving the accuracy of physicians' diagnostic estimates.

1991

Doepke, K. J. (1991). Multiple-cue conditional discrimination training with children with autism: Effects on receptive and expressive language tasks. Dissertation Abstracts International, 52(12-B, Pt 1), 6655.
Research has shown that children with autism exhibit deficits in responding to complex, multi-component stimuli. It has been hypothesized that this deficit is related to concomitant

language difficulties. This investigation examined the relation between autistic children's responses to language-relevant multi- component stimuli and their performance on simple and complex language tasks. Five children with autism (ranging in age from 9-16 years) participated in this investigation. Initial assessments of their responses to six simple and complex language tasks were conducted. Specifically, three receptive language measures (structured table task, standardized language assessment, and naturalistic instructions) and three expressive language tasks (expressive responses to table task materials, expressive responses to pictures, expressive responses to naturalistic stimuli), each containing from one- to four-components were used. Using a multiple-cue conditional discrimination training paradigm, the children then were taught to respond to the receptive language structured table task at gradually increasing levels of difficulty (i.e., one-, two-, three-, and four-component tasks). Three of the participants were taught to respond to up to four- component stimuli. The remaining two were taught to respond to up to three-component stimuli. Following acquisition of responding at each level of complexity, generalization probes across the five additional language tasks (two receptive and three expressive) were conducted. Initial assessments found, similar to previous investigations, that as language tasks increased in complexity (from one to four components), performance generally deteriorated. Additionally, the children performed at higher levels of accuracy on receptive as compared to expressive language tasks. When multiple-cue conditional discrimination training was instituted, four of five children showed gains in correct responses to the table task. The extent to which these gains generalized to other receptive and expressive language tasks varied across individuals. Specifically, three of five children exhibited generalization to the receptive language measures. Two of five children exhibited generalization to expressive language measures. Three general observations were noted in the generalization assessment data. First, consistent with initial assessment data, subjects generally performed better on receptive language tasks than on expressive language tasks across successive probes. Second, although the overall performance on receptive tasks was better than on expressive tasks, there was no indication that the subjects demonstrated increased generalization to receptive tasks. In fact, expressive and receptive generalization scores often showed parallel functions across successive probes. Third, generalization was more evident in children taught to respond to up to four-component stimuli, as compared to those taught to respond to up to three component stimuli. Implications for remediating autistic children's deficits in language and responding to other complex tasks via multiple-cue conditional discrimination training are discussed. Further, the importance of defining characteristics of children who would benefit from this type of a program is highlighted.

Knez, I. (1991). Interaction of data and hypotheses in probabilistic inference tasks: Rejection of the hypothesis sampling model? Scandinavian Journal of Psychology, 32(1), 57-69.

Examined the problem of whether or not data influence subjects' sampling hypotheses about functional relations in the probabilistic inference tasks. Forty-eight high school students who participated in the experiment were randomly assigned to six groups. Results show (1) a considerable impact of data on subjects' hypothesis selection and (2) that subjects significantly modify their hypothesis selection from one part of the experiment to the other. Thus, there is an interaction of data and hypotheses in cue probability learning tasks regarding the hypothesis sampling process and an execution of cognitive control over subjects' hypothesis pool.

Koh, K., & Meyer, D. E. (1991). Function learning: Induction of continuous stimulus response relations. Journal of Experimental Psychology: Learning, Memory, and Cognition, 17(5), 811-836.
This research investigates how people learn to select particular response magnitudes along one physical dimension (duration) when given stimulus magnitudes from another dimension (spatial extent). Eighteen college students participated in three experiments. Stimuli and correct responses were related by either a power function, a logarithmic function, or a linear function with a positive intercept. The power function was learned quickly and accurately. In contrast, systematic response biases occurred during the early phases of learning the logarithmic and linear functions. As practice progressed, however, the biases gradually disappeared. These results support an adaptive regression model. According to it, people learn functions through a subjective process analogous to statistical regression. There is assumed to be an initial constraint that treats stimulus response pairs as if a power function characterizes them.

Sawyer, J. E. (1991). Hypothesis sampling, construction, or adjustment: How are inferences about nonlinear monotonic contingencies developed? Organizational Behavior and Human Decision Processes, 49(1), 124-150.
Studied 155 college students' ability to detect nonlinearities in monotonic increasing contingency functions. The probabilistic nature of the contingency function along with the amount of information available to learn the contingency function affected the extent to which subjects learned the degree of nonlinearity in the function form. Subjects learning a highly predictable contingency function initially hypothesized a linear function and gradually adjusted the form of their response functions to fit the nonlinearity of the stimulus function. Subjects learning a less predictable contingency function tested alternative hypotheses about the function form but eventually returned to estimating a positive linear contingency function. The number of learning trials had a significant effect on subjects' ability to match the stimulus function. Two different monotone increasing functions were investigated.

1992

Balzer, W. K., Sulsky, L. M., Hammer, L. B., & Sumner, K. E. (1992). Task information, cognitive information, or functional validity information: Which components of cognitive feedback affect performance? Organizational Behavior and Human Decision Processes, 53(1), 35-54.
One hundred and thirty-three undergraduates were randomly assigned to one of five cognitive feedback (CFB) conditions: task information (TI) only, cognitive information (CI) only, TI + CI, TI + CI + functional validity information, or no feedback. Subjects completed a multiple cue probability learning (MCPL) task, predicting number of wins for major league baseball teams. Subjects returned a week later, received the CFB appropriate for their experimental condition, and repeated the judgment task. Traditional measures of performance on MCPL tasks were collected, along with measures of accuracy of predictions and self-report measures of understandability and helpfulness of feedback. Subjects who received a TI condition showed significantly better performance than subjects who received no feedback as indicated by validity and accuracy measures of performance.

Castellan, N. J. (1992). Relations between linear models: Implications for the lens

model. Organizational Behavior and Human Decision Processes, 51(3), 364-381.
Brunswik's (1956) lens model (LM) has been widely used in the modeling and analysis of judgment tasks, and the LM equation has been an important part of most analyses. In such analyses, researchers often have based arguments and interpretations on the magnitude of various components of the LM equation. One component is G, an index of agreement between a linear model of the subject's judgments and a linear model of the task environment. Examples of a 2-cue problem and a 3-cue problem illustrate how the LM has been used as an interpretive tool. It is shown that the distribution of G is often skewed toward high values so that caution must be used in the interpretation of its magnitude. Moreover, the results apply to the relation between linear models in general. ((c) 1997 APA/PsycINFO, all rights reserved)

Edgell, S. E., Bright, R. D., Ng, P. C., Noonan, T. K., & Ford, L. A. (1992). The effect of representation on the processing of probabilistic information. In B. Burns (Ed.), Percepts, concepts, and categories: The representation and processing of information (pp. 569-601): Amsterdam, Netherlands: North-Holland.
(from the book) [investigates] subjects' utilization of probabilistic information / on each trial of . . . [eight] experiments, a subject views a multiattribute cueing stimulus, predicts which of two levels of the single varying attribute of a second outcome stimulus will obtain, and observes the outcome event(from the chapter) salience and unitary stimuli / salience and separable stimuli / salience manipulated / the salience of shapes / [a commentary by A. Smith follows the chapter] ((c) 1997 APA/PsycINFO, all rights reserved)

Edgell, S. E., & Morrissey, J. M. (1992). Separable and unitary stimuli in nonmetric multiple-cue probability learning. Organizational Behavior and Human Decision Processes, 51(1), 118-132.
Two experiments with 140 undergraduates were run to study the effects of separable and unitary stimuli dimensions in a probabilistic, decision-making-like environment. Using a nonmetric multiple-cue probability learning task with two relevant dimensions and additional relevant configural information, no differences in utilization were found for these two types of stimuli. However, in an environment that subjects found more difficult, one in which one dimension is relevant along with the pattern of two additional dimensions, an effect was found. Unitary stimuli were found to facilitate utilization of configural information, but no difference was found for utilization of dimensional information. ((c) 1997 APA/PsycINFO, all rights reserved)

Knez, I. (1992). Estimation of the hypothesis hierarchy in probabilistic inference tasks. Scandinavian Journal of Psychology, 33(1), 47-55.
Attempted to extend Brehmer's two rank-order estimation experiments and to yield an evaluation of the possible impact of data on subjects' estimations regarding the strength of their hypotheses. Two experiments, involving a total of 48 undergraduates, were conducted. Results indicate a consistency with Brehmer's hierarchical assumption only regarding the relation between the linear and nonlinear rules, but not within these types of rules. Subjects did not have several hypothesis hierarchies relating different cue values, and the rank order among the hypotheses could be interpreted as hierarchical but only between hypotheses about polynomials of the first and second degree. ((c) 1997 APA/PsycINFO, all rights reserved)

Knez, I. (1992). Subjects' inferential performance and the interaction of data and hypotheses in probabilistic inference tasks. Scandinavian Journal of Psychology, 33(1), 56-67.

Examined whether different forms and orders of data presentation would influence subjects' inferential performance. In accordance with results previously obtained by the author, it was expected that the interaction of data and hypotheses concerning the hypothesis sampling, as well as the subjects' cognitive control over their hypothesis pool, should be reflected in subjects' inferential performance. Subjects were 48 high school students. Results reveal a consistency with the earlier findings in that subjects' hypothesis testing was significantly influenced by the different cue positions and training blocks. Thus, there was an interaction of data and hypotheses and an execution of cognitive control over the hypothesis pool. ((c) 1997 APA/PsycINFO, all rights reserved)

Poses, R. M., Cebul, R. D., Wigton, R. S., Centor, R. M., & et al. (1992). Controlled trial using computerized feedback to improve physicians' diagnostic judgments. Academic Medicine, 67(5), 345-347.

Tested a method to improve physicians' diagnostic judgments by integrating the use of a computer program (employing cognitive feedback to teach a clinical rule), a traditional lecture, and periodic disease-prevalence reports. In a controlled trial using pre- and postintervention measures involving 885 patients, the effects of the integrated method on the diagnostic judgments of seven experienced physicians were compared with the effects of the lecture alone on the judgments of seven other experienced physicians. The integrated method improved the quality of the subjects' judgments and increased the level of agreement between the subjects' judgments and those made by the clinical prediction rule. The lecture alone produced less improvement in the quality of the subjects' judgments and decreased the level of agreement with the rule. ((c) 1997 APA/PsycINFO, all rights reserved)

Tape, T. G., Kripal, J., & Wigton, R. S. (1992). Comparing methods of learning clinical prediction from case simulations. Med Decis Making, 12(3), 213-21.

Feedback to physicians about how they use information in making judgments can improve the quality of their judgments, but questions remain about which types of feedback are most effective. The authors conducted a controlled study of feedback in 60 medical students learning to predict the risk of cardiovascular death based on the presence or absence of five risk factors. After a pretest of 40 cases abstracted from patient records, the students worked through 173 computer-simulated cases and a posttest of 40 patient cases. The students received no feedback, probability feedback (correct probability of cardiac death for each case), cognitive feedback (the correct cue weights compared with their own weights derived from the previous set of cases), or both types of feedback. Students who received probability feedback markedly improved both base rate calibration and discrimination. Those who received only cognitive feedback showed no improvement over control on any of the measures of learning. All subjects were highly consistent in their weightings. The superiority of probability feedback differed from previous findings that cognitive feedback was essential for mastery of multiple-cue-probability learning tasks. The information on cue-outcome relationships given by cognitive feedback may be more useful when these relationships are complex and the combining rule is not known, while the precise outcome information provided by probabilistic feedback is more useful when the combining rule is known and the cue-outcome relationships are straightforward. Thus, the optimal method of learning depends on the nature of the task.

Taylor Lewis, A., III, Cosier Richard, A., & Ganster Daniel, C. (1992). The positive effects of easy goals on decision quality and risk propensity in an MCPLP task. Decision Sciences. Jul/Aug, 23(4), 880-898.

A study examined the potential performance benefits of easy goals within the multiple cue probability learning paradigm (MCPLP). Specifically, the effects of varying levels of goal difficulty on performance and risk propensity (used to define a form of commitment) were investigated. With few exceptions, previous studies demonstrated support for difficult goals. Contrary to the majority of past evidence, however, the current study showed that as goals became easier, decision quality significantly improved. Moreover, risk propensity increased with easier goals and, as suggested by a post-hoc analysis, had more direct impact on decision makers' behavior than goal levels. Goal-related behavior in complex MCPLP tasks appears to significantly differ from the majority of goal evidence in other types of research due to the tendency for subjects to view complex task properties in the same context as goal levels.

1993

Edgell, S. E. (1993). Using configural and dimensional information, Castellan, N. John Jr. (Ed); et al. (1993). Individual and group decision making: Current issues. (pp. 43 64). Hillsdale, NJ, USA: Lawrence Erlbaum Associates, Inc. .
(from the chapter) [focuses] on the effect that the environment has on the cognitive processes of the decision maker / focuses on the utilization of dimensional and configural information / the question of whether it is harder for the decision maker to utilize configural information than to utilize dimensional information is explored / whether there are interactions of having one type of relevant information in the environment on the cognitive use of the other type is then examined /// multiple-cue probability learning / measuring validity and utilization / do dimensional and configural processing interact ((c) 1997 APA/PsycINFO, all rights reserved)

Edland, A. (1993). The effects of time pressure on choices and judgments of candidates to a university program. .
(from the chapter) an important characteristic of human decision making is that decisions in everyday life often have to be made under deadline conditions / these deadlines may engender feelings of time pressure / the purpose of the present study is to extend an earlier study by Svenson, Edland, and Slovic (1990) that examined time-pressure-induced changes in strategy when choosing between alternatives that were incompletely described / Svenson et al . . . found that time pressure resulted in a shift toward a strategy enhancing positive information / the present experiment attempts to supplement these results by determining whether similar changes in strategy occur when alternatives are described completely / [the effects of time pressure were considered in terms of] the judgments of differences in attractiveness between the alternatives / [Subjects were 20-40 yrs old] ((c) 1997 APA/PsycINFO, all rights reserved)

Ganzach, Y. (1993). Predictor representation and prediction strategies. Organizational Behavior and Human Decision Processes, 56(2), 190-212.
Tested the hypothesis, in Exp 1 with 290 undergraduates, that reliance on representativeness will increase when predictions are based on predictors that are represented visually rather than numerically. In Exp 2, with 40 undergraduates, the hypothesis that reliance on representativeness will increase if subjects are provided with a frame of reference for the predictor by informing them about the predictor's scale was examined. In both experiments, extremity and consistency of predictions were used as indicators for reliance on representativeness. Results of Exp 1 indicate that (1) predictions were more extreme when they were based on visually represented predictors, but this effect depended on the amount of

outcome feedback and disappeared in high predictor validity and (2) predictor representation interacted with the number of predictors in determining prediction consistency, but this interaction depended on predictor validity. ((c) 1997 APA/PsycINFO, all rights reserved)

Koh, K. (1993). Induction of combination rules in two-dimensional function learning. Memory and Cognition, 21(5), 573-590.

Found that in some situations people can learn multiplicative rules more easily than other (e.g., additive) rules. Results from three experiments with a total of 15 university students show that subjects learned to produce specified response durations when presented with stimulus lines varying in length and angle of orientation. When stimuli and correct responses were related by a multiplicative combination of power functions, learning was relatively easy. In contrast, systematic response biases occurred during the early phases of learning an additive combination of linear functions and a more complex (nonadditive and nonmultiplicative) combination of linear functions, suggesting that people have a tendency to induce a multiplicative combination of power functions. ((c) 1997 APA/PsycINFO, all rights reserved)

McDonald, J. L. (1993). The acquisition of categories marked by multiple probabilistic cues, Nakamura, Glenn V. (Ed); Medin, Douglas L. (Ed); et-al. (1993). Categorization by humans and machines. The psychology of learning and motivation: Advances in research and theory, Vol. 29. (pp. 129-156). San Diego, CA, USA: Academic Press, Inc. .

(from the chapter) [reviews the use of] the competition model, together with a learning-on-error mechanism, . . . in predicting the course of cue acquisition and cue strength at mastery for a special kind of ill-defined categorization problem / these categories are marked by multiple probabilistic cues governed by a dominance hierarchy /// the competition model / testing model in the psycholinguistic domain / testing of the model in the concept learning domain / other possible realms for the competition model [grammatical gender, dative verb subclasses, word meaning, medical diagnosis task] ((c) 1997 APA/PsycINFO, all rights reserved)

Sawyer, J. E. (1993). Judgment of nonlinear contingencies and applications of contingencies to organizational behavior. In N. J. J. Castellan (Ed.), Individual and group decision making: Current issues (pp. 65-86). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

The primary goals of this chapter are to (a) identify consistent biases in the judgment and use of nonlinear covariation rules and (b) discuss an application of covariation judgment to organizational behavior. Biases in the judgment of covariation rules stem from uncertainty in the covariation context and are consistent with finding regarding responses to uncertainty in other contexts. An application of covariation judgment to organizational behavior is discussed within the context of social judgment theory. It is proposed that covariation judgments be used in a normative fashion to guide behavior in work settings. Research attempting to develop an application of covariation judgment to a normative model of performance assessment and feedback is presented. Correspondence between the productivity measurement and enhancement system (ProMES) measures and shared supervisor ratings is indexed by the lens model equation.

1994

Ganzach, Y. (1994). Feedback representation and prediction strategies.

Organizational Behavior and Human Decision Processes, 59(3), 391-409.
Assessed the influence of feedback representation on prediction in a single cue probability learning paradigm. Two types of feedback representation were examined: deviation representation, in which the feedback is the magnitude, or even just the sign, of the prediction error, and standard representation, in which the feedback is the outcome itself. Two hundred and forty-five subjects participated in three experiments. It was found that when the predictor is represented visually (rather than numerically), and when the outcome scale is unknown, deviation representation results in higher prediction extremity than standard representation. In addition, deviation representation results in higher prediction consistency than standard representation. Findings are explained as resulting from more reliance on the representativeness heuristic in the deviation representation conditions. ((c) 1997 APA/PsycINFO, all rights reserved)

Headrick, L., Kaufman, A., Stillman, P., Wilkerson, L., & Wigton, R. (1994). Teaching and learning methods for new generalist physicians. J Gen Intern Med, 9(4 Suppl 1), S42-9.
This paper describes teaching and learning methods that can be used to build the competencies needed by the generalist physician. Supervised patient care, problem-based learning, and ongoing feedback through standardized patients all have proven efficacy in several domains. Computer-based learning has much to offer as a supplement to clinical teaching. New learning experiences in continuous improvement promise to cover areas that are not often reached by traditional methods, especially those of cost-effectiveness and quality of care. The authors review each method's principles, relationship to generalist competencies, examples of effective applications, and challenges to successful implementation. Where possible, they summarize what is known about the relationships of learning and teaching methods to career choices in generalism.

Tsao, C. J. (1994). Factors affecting multiple-cue-probability learning: Evaluative feedback and time pressure. Dissertation Abstracts International Section A: Humanities and Social Sciences, 55(11-A), 3458.
This dissertation examines the effects of evaluative feedback (positive vs. negative) and time pressure (presence vs. absence) on learning in a multiple-cue probability learning task. In each of the four conditions, subjects were asked to predict the criterion value given three cues with weights of 0, .33, and .67. The results show that undergraduate subjects learned better when the evaluation system was biased to provide positive rather than negative feedback, and in the absence rather than the presence of time pressure. Regarding cue utilization, subjects tended to give equal weights to all the cues. As a result, they gave too much weight to the irrelevant cue and too little to the most important cue. This tendency was worse when the evaluation system was biased to provide negative rather than positive feedback, and in the presence rather than the absence of time pressure. In addition, Easterbrook's (1959) hypothesis that under time pressure, subjects reduce the range of cue utilization was only partially supported. At the initial stage of learning, a smaller percentage of subjects used the irrelevant cue when there was time pressure than when there was not. However, after they adapted to time pressure, the percentage of subjects using the cues increased to a level equivalent to those who were not under time pressure.

1995

Edgell, S. E., & Roe, R. M. (1995). Dimensional information facilitates the utilization

of configural information: A test of the Castellan-Edgell and the Gluck-Bower models. Journal of Experimental Psychology: Learning, Memory, and Cognition, 21(6), 1495-1508.
In four experiments involving learning in a probabilistic environment (a nonmetric multiple-cue probability learning environment) the authors found that utilization of relevant configural information was facilitated when any relevant dimensions were part of the relevant pattern. Relevant configural information in an environment with no relevant dimensions was as highly utilized as when the pattern contained the relevant dimension. With two relevant dimensions, the dimension within the relevant pattern was more highly utilized than the dimension not in the relevant pattern. Both Castellan and Edgell's hypothesis testing model and Gluck and Bower's connectionist model were unable to fit several aspects of the findings.

Ganzach, Y., & Czaczkes, B. (1995). The learning of natural configural strategies. Organizational Behavior and Human Decision Processes, 63(2), 195-206.
Studied the learning of either a disjunctive strategy, in which response depends primarily on the high cue, or a conjunctive strategy, in which response depends primarily on the low cue, in a two-cue probability learning paradigm with 138 undergraduates. Results show subjects learn disjunctive strategy better when the target of the prediction is human than when it is non-human, and they learn conjunctive strategy better when the target is non-human. In addition, in a meaningful context, conjunctive strategy is learned better in the short run, but after a prolonged feedback, disjunctive strategy is learned better. In an abstract context, disjunctive strategy is learned better both in the short and long run. The processes that lead to these differences in the learning of conjunctive and disjunctive strategies are discussed.

1996

DeShon, R. P., & Alexander, R. A. (1996). Goal setting effects on implicit and explicit learning of complex tasks. Organizational Behavior and Human Decision Processes, 65(1), 18-36.
Determined whether the moderating effect of task complexity on the goal-performance relationship would be due to confounding goal difficulty with explicit and implicit learning. Two multiple cue probability learning studies were performed, keeping the learning mode constant while varying goal difficulty. Study 1, conducted with 124 university students, examined goal setting effects on performance when task processing was implicit. Setting difficult, specific goals did not result in performance gains. Study 2, conducted with 128 university students, demonstrated that when complex task processing is explicit, goal setting results in gradual but steady improvements in complex task performance. Protocol analysis of strategies used by participants indicate that goal setting resulted in increased performance through the development of better strategies.

Taylor, L. A., III, Hall, P. D., Cosier, R. A., & Goodwin, V. L. (1996). Outcome feedback effects on risk propensity in an MCPLP task. Journal of Management, 22(2), 299-311.
Assessed the effects of outcome feedback on subsequent decisions by 120 undergraduate business students engaged in an individual financial prediction task. The task fell within the multiple-cue probability learning paradigm (MCPLP) in that subjects had to use three cues to predict price-earnings ratios over 20 trials. Subjects received outcome feedback on a decision-by-decision basis. It was hypothesized that outcome feedback on each decision

would influence the decision to risk (commit) resources in a hypothetical company. Hierarchical regression analyses revealed that after all other performance effects had been partialed out, current outcome feedback explained much of the commitment decision in this task characterized by uncertainty, complexity, and incomplete information. ((c) 1997 APA/PsycINFO, all rights reserved)

1997

Chasseigne, G., Mullet, E., & Stewart, T. R. (1997). Aging and multiple cue probability learning: The case of inverse relationships. Acta Psychologica, 97(3), 235-252.
Multiple cue probability learning (MCPL) is an important cognitive ability for all age groups that, like other cognitive abilities, depends on information processing speed and working memory capacity--skills that have been found to decline with age. The relation between age and ability to learn direct and inverse probabilistic relationships was studied in MCPL experiments with men and women aged 20-30 vs 65-75 vs 76-90 yrs. In Exp 1, subjects learned two 3-cue tasks following the MCPL paradigm. In the first task, all cues had a direct relation (DR) with the criterion. In the second, one cue had an inverse relation (IR) with the criterion. In the DR task, older subjects were able to learn nearly as well as younger subjects. In the IR task, older subjects performed significantly worse than younger subjects due to an inability to use the inverse cue. In a second experiment involving the IR task, task information (TI) was given, with the relation between each cue and the criterion explicitly described, thus reducing the burden on working memory. Provision of TI resulted in improved performance for 20-30 and 65-75 yr olds, but not the oldest group. Differences in performance among age groups remained. The results cannot be fully explained by differences in working memory; flexibility of functioning may also play a role. ((c) 1998 APA/PsycINFO, all rights reserved)

1999

Kruschke, J. K., & Johansen, M. K. (1999). A model of probabilistic category learning. Journal of Experimental Psychology: Learning, Memory, and Cognition, 25(5), 1083-1119.
A new connectionist model (named RASHNL) accounts for many "irrational" phenomena found in nonmetric multiple-cue probability learning, wherein people learn to utilize a number of discrete-valued cues that are partially valid indicators of categorical outcomes. Phenomena accounted for include cue competition, effects of cue salience, utilization of configural information, decreased learning when information is introduced after a delay, and effects of base rates. Experiments 1 and 2 replicate previous experiments on cue competition and cue salience, and fits of the model provide parameter values for making qualitatively correct predictions for many other situations. The model also makes 2 new predictions, confirmed in Experiments 3 and 4. The model formalizes 3 explanatory principles: rapidly shifting attention with learned shifts, decreasing learning rates, and graded similarity in exemplar representation. ((c) 1999 APA/PsycINFO, all rights reserved)

This was the final entry as of 10/16/99.

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