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SITUATIONAL INFLUENCES ON NONLINEAR INFORMATION PROCESSING

By

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ABSTRACT

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INFORMATION PROCESSING

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Previous research indicated that linear models provide a good approximation of how information is used to make decisions in a wide variety of judgment situations. In comparison, empirical support for nonlinear and curvilinear judgment strategies was rare. Einhorn (1970) offered the conjunctive model, representing a multiple cut-off decision strategy, as an alternative to the linear model. He demonstrated that the conjunctive model represented a more appropriate decision strategy when the cost of false positive decision errors was high.

This investigation was designed to systematically study effects of the decision context on nonlinear information processing. In two separate experiments, factors hypothesized to effect the cost of false positive decision errors and use of the conjunctive model were varied. Factors hypothesized to encourage use of nonlinear models were the decision makers' experience with the judgment task, cue labels, high decision cost instructions and loss of money for decision errors. Information use was studied in a 2 (novice, expert judge) by 2 (cue labels absent, present) by 2 (low, high decision cost) by 2 (linear, conjunctive model) design in one study and a 2 (no pay, pay) by 2

(labels present absent) by 2 (low, high costs) by 2 (linear, conjunctive model) in a second study.

Subjects in both studies were asked to rate the expected level of job performance for 40 college graduate job applicants. The ratings were based on six numerical sources of information presented to the subjects on each applicant. In labelled conditions, sources were identified with cue labels: dependability, experience, references, oral communication, class standing, and intelligence.

Multiple correlations, reflecting how well a model accounts for the subjects' use of information, of the cue values with success ratings served as the dependent measure. For the conjunctive model, logarithmic transformations of cues and ratings were performed before the computation of the multiple correlations. The multiple correlations were transformed to Fisher Zs and submitted to analyses of variance.

Consistent with previous research, the results indicated that the linear model provided a better representation of subjects' judgment in general. The conjunctive model equalled the ability of the linear to account for judgments in the high cost condition of study one. In study two, models performed equally in labelled, low cost conditions. The discrepancy between study one and two in terms of decision cost were attributed to increased ego involvement generated by modification of the instructions in study two. Thus while not yielding conjunctive superiority, the experiments did demonstrate conditions in which the conjunctive model was a more accurate representation of subjects' judgments.

The label and judge factors influenced information processing overall. Labelled cues resulted in more consistent use of information,

supporting previous research. Expert judges were also more consistent in their information use than novices. The judge effect was attributed to greater involvement and familiarity with the task. Pay had no effect on decision making.

Configural models were developed for each judge as an alternative to linear and conjunctive models. In both studies, configural models provided the best fit of information use for a majority of judges. While the absence of any pattern in configural term usage may suggest that configural terms were spurious, the magnitude of increments over linear models demonstrated that some subjects may have engaged in some form of nonlinear information processing.

It was suggested that future research should develop better operationalizations of high decision cost to further test the conjunctive model. Use of learning paradigms to provide additional knowledge of learning rates for the conjunctive model in comparison to the linear and other nonlinear models was also discussed.

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INTRODUCTION

As Toffler (1970) pointed out, we live in a technological civilization inundated with information. Adapting to this ever-changing environment requires an ability to obtain information about certain regularities in the environment and then to use the information to respond appropriately. Information processing and the subsequent judgments and decisions made are very important processes. These fundamental cognitive processes are essential to the survival of everyone. The types of decisions required may range from selecting which loaf of bread to buy at the local store to determining priorities for the funding of alternate sources of energy. The cognitive activity of individuals in our civilization has been credited with many significant accomplishments, but also a number of dismal failures. Such a pervasive, and at times significant activity, merits careful study. Stated more earnestly

> It is only natural that an increasing number of thoughtful and socially concerned individuals should be coming to believe that one of the most urgent tasks for our society is the development of a body of scientific knowledge that will enable us to understand more of the capacities and limitations of human information processing . . . (Estes, 1975, p. 2).

While decision making and other cognitive processes have recently been the subject of increased scientific investigation, the study of cognitive activity is by no means new. The following review discusses some of the historical influences on modern cognitive psychology.

Early Views of Cognitive Activity

Wilhelm Wundt is generally credited with establishing the first psychological laboratory in Leipzig in 1879. He studied conscious experiences through the method of introspection. By systematically reporting experienced sensations in a controlled manner he hoped to gain insights into the mind. Together with his student, Edward W. Titchener, they established the first school of thought in psychology, Structuralism, which attempted to reduce immediate experience to elementary structural components (Schultz, 1969).

The approach which supplanted structuralism as a theoretical basis of early psychology was functionalism. One of the leading advocates of functionalism, James R. Angell, defined their approach (more consistently with modern cognitive psychology) as the study of mental operations. They were not concerned with elements, but with processes involved in mental activity. Angell (1907) viewed the role of the mind as mediating between the environment and the needs of the organism.

The study of cognitive activity was temporarily suppressed by Watson and the strict behaviorists. Their emphasis on studying only molecular stimulus-response relationships, which are directly observable, did not allow the study of mental processes, except on an observable, physiological level. Watson went so far as to suggest never using terms like consciousness, mental states and the mind. Behaviorists aided cognitive research through their objective research methods and by stressing the role of the environment in influencing behavior.

It was a later behaviorist, E. C. Tolman, who began to soften Watson's position and give some legitimacy again to the study of cognitive processes. Tolman viewed behavior more on a molar level, i.e., the response of the whole organism, rather than glands or nerves. Instead of simple S-R relationships, Tolman placed the organism in between the stimulus and response to postulate S-O-R relationships. He believed that a set of inferred, unobserved factors were the actual determinants of behavior (Schultz, 1969). Tolman viewed the intervening organism as a purposive, goal seeking creature. It again became acceptable to study mental processes, but the intervening variables describing what was going on within the individual, became acceptable in developing a theory only when they were shown to be empirically related to both experimental and behavioral variables. Thus, Tolman not only put cognition into his theory, but also set some rigorous guidelines for the study of cognitive variables.

This brief review was intended to demonstrate the role that the investigation of mental activity has played in psychology from the science's infancy. Early psychologists gave mental operations a central role in their theories, and later behaviorists established more rigorous methods for the study of cognitive variables. Modern research on decision making has its roots in these pioneering areas.

Basic Approach and Terminology

Before examining current research and theory, a clarification of terms is necessary. A number of different topics are included under the aegis of cognitive psychology (e.g., memory, motivation, perception, language acquisition, etc.). This paper restricts its study of cognitive activity to the use of information by individuals in making decisions. It will not focus on processing at a neural level but upon the grosser processes employed by humans in integrating information in reaching decisions. In this regard, the terms judgment, decision making and information processing are used interchangeably.

A question might be raised concerning how the use of information to make decisions can tell us anything about cognitive activity. Mental processes are generally considered subjective, and as a private experience are not observable. Maintaining both a molar perspective on behavior and an objective level of description requires some assumptions, which have been discussed by Hoffman (1960). To describe and investigate judgment, a set of techniques and a theoretical system must be interposed between two sets of observable entities. In controlled settings where a quantifiable input (information) and quantifiable output (judgment) are known, functional relationships, described by mathematical models, can be used to objectively infer the unobserved mental activity. There is no certainty that any particular functional relationship is in fact being used by the judge to make decisions, but to the extent that such a relationship allows one to accurately predict responses given varying informational inputs, the procedure serves as a simulation of how information is used. This method proposes a means for describing Tolman's intervening organismic variables, which Hoffman (1960) termed the paramorphic representation of human judgment.

The functional relationships are by inference assumed to represent the process followed by each individual's cognitive system in making decisions. Rappoport and Summers (1973) further explain.

> A <u>cognitive system</u> is any minimally organized set of relationships between an individual's judgments and the information ("cues") on which the judgments are based. In connection with judgment phenomena, cognitive systems can be thought of as <u>policies</u>. That is, to the extent that an individual finds meaning in a body of uncertain information, he does so through application of an implicit

> or explicit policy concerning (1) the causal relationships indicated by the information, and (2) the relation of his outstanding goals or purposes to that information. Policy can include anything from the use of certain criteria by a graduate student selection committee to a political leader's reliance upon reconnaissance photographs (rather than statements by Soviet leaders) when making a judgment about the presence of "offensive" missiles in Cuba. Technically, a policy may be seen as a set of rules for utilizing available evidence in order to reach a decision in an uncertain situation (p. 4).

Using function relationships to represent the cognitive system or policy of judges has been termed policy-capturing (Dawes & Corrigan, 1974).

Another aspect to consider in decision making is the environmental system, or the situation in which the decision is being made. As the cognitive system is comprised of individuals' perceived relationships between input information and their judgments, the environmental system or decision task includes relationships (actual, not perceived) among environmental events and a criterion (if available). In the previous graduate admissions example, the environmental system is comprised of relationships among available characteristics of the applicants, plus the relationship between the characteristics and an eventual success (graduate school or career) criterion (Rappoport & Summers, 1973).

In studying decision making, both cognitive and environmental systems must be considered since certain cognitive systems may be more functional in some environments than in others. A number of possible interactions between cognitive and environmental systems could influence information processing.

Rappoport and Summers (1973) delineated a number of different types of cognitive-environment relationships with the distinguishing feature among them being the number of separate cognitive systems (i.e., individuals) studied. Single systems focus on one judge making individual decisions. Multi-judge systems have two or more judges interacting in making their decisions. Bargaining situations or the three party attraction paradigms of Heider (1958) are examples of multi-judge system. The present study restricts itself to the single system type. In this system, the person makes judgements individually on the basis of information which is not completely reliable and valid. For example, a radiologist has to categorize patients on the basis of somewhat ambiguous symptoms. Even after decisions are made, confirmation of the correctness of the decision may be difficult because of long time intervals or confounding factors present in ambiguous situations. Thus, the primary focus of the single system research paradigm is upon the cognitive system of the judges.

The specific methodologies and techniques employed in decision making research will be discussed in the literature review which follows.

Recent Approaches to Information Processing: Two Paradigms

As the earlier historical section indicated, psychologists have been studying cognitive processes since the very beginning. However, the recent molar approach to investigating the use of information in making judgments began in the early 1960s. Prior to that point, most of the research was done on a molecular level of behavior analysis. Advances in computer technology at that time further aided the development of this quantitatively oriented area of study.

Modern research on human judgment has been reviewed by Slovic and Lichtenstein (1971). In their monograph, they concluded that much of the recent research can be categorized into two basic methodological approaches. Each approach has certain tasks and types of input information which are characteristic of that method. One approach was based on the conditional probabilities of Bayes' Theorem. Although Bayesian research is not the focus of this discussion, the interested reader can consult the monograph for more information. The other approach Slovic and Lichtenstein termed "regression" since the principle analysis tools are multiple regression and its dummy coded derivative, analysis of variance. The regression methodology has two variants: the learning paradigm, and the policy-capturing paradigm.

Learning Paradigm

Recent regression approaches to judgment research are based heavily on the work of Egon Brunswik. His thinking also provides a link between traditional schools of thought in psychology, as previously discussed, and current perspectives. Brunswik, a colleague of Tolman's for a number of years, combined the behaviorists' stress on objectivity, Tolman's emphasis on molar, purposive behavior and the earlier functionalists approach of studying the adaptive interrelationship between the organism and its environment. He further added the notion that the environment is uncertain or probabilistic and that research designs should be representative of that erraticism (Brunswik, 1955). Kenneth Hammond (1966, p. 22) somewhat panegyrically described Brunswik as "the first probability theorist in modern psychology as well as the first psychologist to challenge the precepts of orthodox experimental design."

The concepts of cognitive and environmental systems discussed in the previous section are derived from Brunswik's work. Although his own research was concerned primarily with perception, his constructs and methods have been widely applied (as will be indicated). He noted that in an uncertain environment an individual decision maker should not place a great deal of trust in the information in any one cue. To make a more sound decision, multiple cues are accumulated and combined. Thus, a general feature of judgment research is the presentation of multiple information cues to serve as the basis for individual decisions. Consistent with his notion of representative design, the decision situation and relationship among the cues should be representative of the settings in which the people typically decide.

By utilizing a paradigm which represented environmental as well as individual factors, Brunswik was able to vary the type and magnitude of relationship between information cues and some environmental criterion (e.g., success in graduate school). In this way he represented the uncertainty of information in the environment in different ways. The correlation of each cue with the criterion was termed its ecological validity. Nonlinear cue-criterion relationships could also be represented by using nonlinear (e.g., logarithmic or exponential) functions or configural terms.

Over a series of trials, multiple cues are presented to subjects and their judgments obtained. The correlation of the subjects' judgments with the criteria values indicates the accuracy of the judgments. For information on other judgment indices, such as accuracy and matching, and their mathematical relationships, see Hursch, Hammond, and Hursch (1964) and Tucker (1964). Hammond and Summers (1972) have pointed out that accuracy involves two steps: acquiring knowledge of the system (i.e., environmental relationships) and then applying that knowledge in consistently weighting the cues in making judgments. The Brunswikian paradigm can be used to study the learning of environmental relationships by presenting the criterion to the subject on each trial after they have made their decision. By giving outcome feedback (i.e., the criterion value) to subjects, the researcher can then examine over trials if the subjects' use of information matched the environmental relationship. The multiple correlation of cues with subjects' judgments provides a separate index of how consistently the judge is applying the knowledge. Through these studies, termed multiple cue probability learning (MPCL) studies, inferences can be objectively made as to how subjects learn cognitive tasks.

Policy-Capturing Paradigm

While the MCPL model has generated much research, the somewhat different approach of Hoffman (1960) has also had great impact. Hoffman's paramorphic representations were developed on clinicians' judgments of Minnesota Multiphasic Personality Inventory (MMPI) profiles. In this and other decision situations (e.g., medical diagnosis) the environmental criterion may not be known, immediately or for some time in the future. Therefore, his research has focused on the cognitive response systems of the judges. As such, Hoffman has placed more emphasis than Brunswik on the models which account for the most consistency in the use of information by judges in making decisions.

He proposed the use of linear and configural models. A linear model describes the judgments in terms of a weighted sum of the information values through multiple regression. The resulting multiple correlation indicates how consistently the judge has used those weights with that model. A configural model describes the judgments in terms of weighted sums of the products (or interaction terms) of information values. Use of interaction terms represents a strategy where the use of one source is contingent upon several others, i.e., the values of several sources are considered simultaneously. Each value is not weighted and summed in isolation.

In his presentation, Hoffman (1960) noted that in some cases, several models might represent judgment with equal proficiency. In those cases, where no model is superior, another criterion must be employed. Models having a rational or theoretical basis may then provide more explanation than post hoc empirical models.

Following Hoffman's (1960) paradigm, many researchers have sought to paramorphically represent the processes of decision makers. In these studies informational cues (ranging in number from two to eleven) are presented to subjects, and they are asked to make a judgment based on the information given. Attempts have been made to capture and characterize the cognitive processes of clinicians' MMPI profiles (Goldberg, 1968, 1971; Wiggins & Hoffman, 1968), faculty making graduate admission decisions (Dawes, 1971; Einhorn, 1971), college students identifying job preferences (Einhorn, 1971), judges deciding workmen's compensation cases (Kort, 1968), radiologists diagnosing ulcers (Hoffman, Slovic & Rorer, 1968), and bank loan officers evaluating an applicant company's likelihood of future success (Libby, 1976).

Across these many and diverse studies, a linear model with weights fitted by a multiple regression procedure has provided the best model of the subjects' actual decisions. In an early review of the literature, Hammond and Summers (1965) concluded that despite clinical teaching and manuals emphasizing nonlinear use of information, linear models were sufficient to account for most of the variation in subjects' judgments. More recently Goldberg (1971) has cogently argued for the superiority of the linear model as representative of clinical judgments by comparing linear and nonlinear models, using data from a study by Meehl (1954). Green (1968) has attributed this "perverse pervasiveness of linearity" to the ability of the least squared approximation method to provide a reasonable fit to the data in all situations where the relationship between the cues and criterion is monotonic. Dawes and Corrigan (1974) used data from several different decision situations to demonstrate how linear methods provide good approximations in situations where the informational cues have a conditionally monotonic relationship with the criterion. Finally, Slovic and Lichtenstein (1971) in their information processing monograph also recognized the strong predictive ability of linear models.

In the face of this rather powerful evidence, nonlinear information processing still seems more intuitively consistent with a view of human decision makers as complex information integrators. The quest for nonlinearity began with Meehl's (1954) article proposing that clinical judgment has the advantage over the linear model in the ability to employ nonlinear judgment policies. While not powerful, there is some evidence that supports the hypothesis that people do use information in decision making in a nonlinear fashion. Wiggins and Hoffman (1968) found that 16 of 29 clinical judges did use information configurally. In analyzing judicial decisions on workmen's compensation cases, Kort (1968) found several multiplicative combinations (i.e., configural terms) which yielded significantly greater predictive power than a linear model. Hoffman, Slovic and Rorer (1968) used an analysis of variance procedure to identify interactive use of cues which made small but significant increments in prediction over a linear model. Valenzi and Andrews (1973) found state employment placement interviewers made configural use of information in evaluating the likelihood of job applicants being hired. Also, Libby (1976) hypothesized that the superiority of actual decision makers over their linear models in a boot strapping study was due to the nonlinear utilization of some pieces of information.

While there are some studies which appear to document the nonlinear use of information by subjects on judgment tasks, the majority of experimenters report little evidence that decision makers use information in a nonlinear or configural manner. In most situations, the linear model seems to provide the best fit for the data. Furthermore, a number of the studies evidencing nonlinear use of information have relied on a variety of statistical techniques to gain small, but significant, increments in multiple correlations. Such haphazard searches for configurality may be merely manipulations of the "decimal dust" residuals of linear models. One philosopher of science has stated,

> . . . the growth of the theories of science should not be considered as a result of the collection, or accumulation, of observations; on the contrary, the observations and their accumulation should be considered as the result of the growth of scientific theories (Popper, 1962, p. 2).

A study of fundamental cognitive processes should begin with psychological theory or research, and then proceed to statistical procedures or models, which operationalize the theory.

Learning Studies With Nonlinear Tasks

In attempts to understand on a more theoretical level the differences between linear and nonlinear information processing, several investigators (Brehmer, 1969, 1971, 1974; Hammond & Summers, 1965, 1972) have taken a different approach to the study of how different functions are used in cognitive tasks. These studies have relied primarily on the learning design of the Brunswikian paradigm, which allows the manipulation of cue-criterion relationships and can provide feedback on correct responses. If subjects are unable to learn nonlinear cognitive tasks, then that finding would explain the poor performance of nonlinear models of information use.

Several studies (Brehmer, 1969, 1973; Hammond & Summers, 1965) have demonstrated that nonlinear cue-criterion relationships can be learned. In one study Brehmer (1969) presented subjects with pairs of lines ranging in length from 1 to 20 cm. They were told that the lines had some relationship to a criterion line (ranging in length from 1 to 250 cm.) and that their task was to find that relationship. After viewing the two cue lines, they estimated a criterion value and then received the actual criterion value. Four different functions related the cues to the criterion: (1) a linear function of the sum of the values, (2) a linear function of the product of the cue values, (3) a linear function of the ratio of the values, and (4) a linear function of the absolute difference of the cue values. The functions varied in linearity in that multiple correlations of the sum of the cues with the criterion yielded values of 1.00, .90, .50, and 0.0, respectively. Over 400 trials the subjects were able to predict the criterion equally well for all cue-criterion relationships, but the rate of learning was slower for the nonlinear functions.

Hammond and Summers (1965) also found that individuals were able to learn to use information to predict criteria based on a nonlinear rule. They presented two numerical cues to subjects and asked them to predict a criterion value. One of the cues was linearly related to the criterion and the other was based on the sine function. In addition, one-third of the subjects were given no prior information about the task, one-third were told that the task involved both linear and nonlinear relationships with a high degree of accuracy requiring use of both types of information, and one-third were not only told of the relationship but were given information as to which was the linear and nonlinear cue. The results indicated that subjects were able to learn to use the cues in a nonlinear (i.e., sinusoidal in this study) manner. Furthermore, those subjects given more information learned the task better. Those subjects given no information tended to use the nonlinear cue in a linear manner (more than the other two groups did). These results seem to indicate that in the absence of any information about the relationship between the cues and criterion, a linear combination rule is used. However, when given information about relationships, people can use information nonlinearly, indicating that the nature of the decision task may be important to information processing.

In another study in which subjects were given information about the task, Brehmer (1971) showed participants a graph of the relationship between the cues and criterion, which they were allowed to study as long as necessary. He employed a positive linear (PL), a negative linear (NL), a symetrical U-shaped (U) where $Y = (X - \bar{X})^2$, and a symmetrical inverse U-shaped function (IU) where $Y = A - (X - \bar{X})^2$. He used the same line task that was used in his previously cited study. However, in this study, subjects were not given the criterion values. Results indicated that the PL and NL functions were more consistently used than the nonlinear ones, with the best performance in the PL condition. In comparing the PL function with the other conditions, it was found that there was more irregular use of information in the other conditions. The most inconsistent use of information was evidenced in the nonlinear (IU,U) conditions. Thus, it appears that knowing the functional rule relating cue to criterion is not sufficient to correctly use that rule.

In a subsequent study, Deane, Hammond and Summers (1972) more explicitly examined the distinction between knowledge and application. On a three cue task, half the subjects were given cues that were linearly related to the criterion and half were given cues that were nonlinearly related. After 20 warm-up trials, all subjects were given knowledge of how the cues were related to the criterion and how they should be weighted. This knowledge was presented in two different ways: verbally or pictorially. After each judgment was made, subjects were given outcome feedback, i.e., told the correct response. Performance was poorer in the nonlinear than linear conditions. (Correlations of subject responses with correct answers were .58 and .84, respectively.). The researchers also calculated an index of knowledge learned, which indicated how well the subjects' weights matched those in the task. The knowledge indices were very similar for both functions. Hence, differences in performance must be attributed to greater difficulties in consistently applying more complex (i.e., nonlinear) information combination rules. Hammond and Summers (1972) termed this application of information, cognitive control.

Other research (Dudycha & Naylor, 1966; Schmitt, Coyle & King, 1976; Schmitt, 1978) had indicated that individuals have difficulty in applying a linear combination rule as well as a nonlinear one. Their analyses revealed that the subjects' weighting of information matched the actual environmental weights, but they were unable to consistently apply those weights. Thus, while cognitive control is not a problem unique to nonlinear tasks, the research of Brehmer (1969, 1971) and Deane, Hammond and Summers (1972) has demonstrated that individuals have more cognitive control on linear tasks than on nonlinear ones.

To try and explain the difficulties in cognitive control with functional relationships, Brehmer (1974) has studied differences in the presence of certain functions in individuals' ecologies. His subjects were shown PL, NL, IU, and U functions (from Brehmer, 1971) and were given a verbal example of each. In one study, subjects were asked to indicate the frequency with which these functions occurred and in another to estimate how difficult they considered finding examples of those functions in another study. PL function was the most frequent and easiest to find with the other functions decreasing in frequency and ease in the same order as above. In a third study he gave students lines and asked them to assign numbers to the lines according to some functional rule. After 20 trials, they were asked to illustrate the rule graphically. They were then given a new set of 20 trials and asked to use a new rule until they had produced 10 rules or could think of no more. The graphs were classified into eight categories with the four most frequent in descending order being PL, NL, IU, and U.

Brehmer (1974) then studied the learning rates of these four functions without informing subjects of the nature of the relationship between the cues and criterion. The results again yielded the same ordering as before. In a fifth study, he used only the positive linear and inverted U functions, but varied the levels of cue validity (.45 and .90). He also asked half of the subjects to report which rule they used after every trial. (By comparisons with control groups, reports were not found to effect performance.) Both cue validity and function form variables had a significant effect on information processing with high validity and PL groups more accurately using the information to predict the criterion. From self-reports, it was revealed that subjects in all groups began by using the PL function. The frequency of PL rules remained constant in the linear conditions and decreased slowly in the nonlinear ones. When the cue validities were low, the nonlinear functions were much harder to find. In fact, all subjects used a variety of rules in the low validity condition, being unable to completely disgard any one.

In summarizing these five experiments, Brehmer (1974) concluded that subjects have response hierarchies about functional relationships which vary in strength. Linear functions (specifically positive linear ones) were found to be most pre-potent in that hierarchy. When cue validities were low, the pre-potent response could not be ruled out and hence persisted in some form. On this basis, he concluded that the structure of the data (i.e., environmental system) influences the selection of hypotheses about relationships among the data.

In evaluating Brehmer's research, one critical point must be noted. Not only is the structure of the data important in the selection of information combination strategies, but also the nature of the decision task. All of Brehmer's studies employed a task with lines of various lengths as cues and criteria. Many of us were taught from early childhood to pair the length of a line with a linear measure of that length. Thus, this specific task rather than the subjects' ecology may be responsible for the indicated response hierarchy. The research of Hammond and associates (Hammond & Summers, 1965; Deane, Hammond & Summers,

1972) utilized a task which was somewhat more generalizable to real life decision situations. Their results clearly indicate that individuals do have more difficulty using nonlinear combination rules. This difficulty may be due to response hierarchies favoring linear functions and/or to the belief that nonlinear policies are more complex and therefore harder to execute (Brehmer, 1973).

All previous studies, evidencing the use of nonlinear policies by decision makers, have done so with the use of configural (i.e., interaction) terms. These terms were empirically derived with no *a priori* basis for the prediction of specific terms. Thus, this support for nonlinear models does not really make a theoretical contribution to the area of decision making research (Popper, 1962). The MCPL studies of nonlinear information processing all employed nonlinear functions which had no rational (i.e., representative) basis. Those functions did not purport to represent any practical, rational decision policy, which may account for the perceived complexity and difficulty in using them.

A Rational Nonlinear Model

An approach, which provides a rational strategy for nonlinear processing, has been developed by Einhorn (1970, 1971). He has proposed several alternative nonlinear information strategies, which while more mathematically complex than linear models, represent means of simplifying the decision task. He termed them conjunctive and disjunctive strategies. These models, representing specific strategies, may not be as hard to apply as other nonlinear models (cf., Brehmer, 1973).

The conjunctive model represents a non-compensatory information combination strategy. The linear strategy is compensatory, i.e., by using a weighted sum, low values on some cues can be compensated for by high values on others. The non-compensatory or multiple cut-off approach is derived from selection research, where there are situations in which a low value on one ability cannot be compensated for by another. For example, poor vision for airplane pilot applicants cannot be overcome by high intelligence. Minimal levels of vision are necessary. In selection, minimal cut-off levels are established on critical predictors and individuals who do not exceed the cut off are not hired. In a broader context, a judge using the conjunctive model would assign low criteria values if any cue values are low.

This model is described by a parabolic function. Mathematically it is operationalized by the equation.

$$\log_{10} Y = b_i \log_{10} (X_i). \qquad (1)$$

where Y = the subject's criterion estimate;

X_i = the information sources or cues;

b_i = the weighting factors for the cues

This negatively accelerating curve has the greatest change in slope in the lower cue value ranges. With logarithmic transformations, the greatest difference in values occurs between 0 and 1, decreasing thereafter. Hence, discrimination is to be maximized at the low values. The logarithmic transformation then allows for the weights to be fitted by multiple regression and the resulting multiple correlations can be then compared with that from the untransformed linear model.

The disjunctive model represents a very different type of decision strategy. A judge using this combination policy should estimate the criterion based on the highest single cue value. This strategy is described by a hyperbolic model. The positively accelerating curve of this model has the greatest change in slope at upper levels of cue values, and hence differences there have a greater impact on criterion estimation than at lower cue values. (No mathematical model is presented since this model will not be used in the current investigation.)

These models simulate simpler cognitive strategies because a judge need not sum or average all cue values. With the disjunctive model, one high cue value can serve as the basis of a decision. For the conjunctive model, one or more low values would suggest a low criterion estimate, irrespective of the remaining cues. Much earlier, Simon (1955) suggested that complex decision tasks could be simplified by a cut-off strategy.

While not stating that these models are most representative of human judgment, Einhor (1971) has hypothesized specific circumstances in which these models might be theoretically more appropriate than a linear combination. Situational factors which might encourage the use of these models were the amount of information presented and the cost of a false positive decision. These factors are characteristics of the decision task.

When large amounts of information are present, a decision maker may have difficulty summing or averaging all cue values to make a judgment. Without a mechanical aid, processing large amounts of information in a linear manner requires the ability to conceptualize and weight each of the values in reaching a decision. As stated above, the conjunctive and disjunctive models allow the decision maker to reduce the amount of information by basing a decision primarily on a limited number of information sources.

However, empirical support for the greater use of nonlinear models in high information situations has not been obtained. Einhorn (1971) reported two studies in support of his theoretical models. However, in neither study was there greater use of nonlinear models as the amount of information increased. In one study, graduating M. B.A.s and industrial engineering students chose the jobs they most preferred. In this study, the conjunctive model outperformed the linear, regardless of the amount of information. The correlations of actual versus predicted decisions, i.e., accuracy, were also higher in conditions where subjects were given two cues, then when they were given four or six. In the second study he reported, faculty and graduate students made decisions about applicants for graduate school. For this task the linear model performed equally as well (i.e., in terms of accuracy) as the conjunctive across information levels. Judgments in the two, four, and six cue information conditions were also significantly different, being less accurate as the amount of information increased. The increase in information did not effect the performance of the models in either study. The absence of time pressures or constraints in both studies may have limited the potential effect of the conjunctive model to reduce information.

More recently, Ogilvie and Schmitt (1978) did obtain changes in model performance as the amount of information increased. Their experimental task required introductory psychology students to rate the likelihood of success for a series of individuals, applying for the job of purchasing agent. The linear model multiple correlations of the cues with judgments were clearly superior to the other models in the two cue condition. In the four and eight cue conditions, the linear and conjunctive models' values were not different, and the multiple correlations for both were lower than in the two cue situation. The authors concluded that a simple averaging of all cues appeared to be more difficult in the higher information conditions. Even this finding provides only minimal support for the hypothesis that nonlinear models reduce the amount of information and simplify the decision task since the conjunctive model was not found to be superior in higher information quantity conditions.

The performance of the disjunctive model in a number of studies (Einhorn, 1971; Goldberg, 1971; Ogilvie and Schmitt, 1978) has been uniformly low and therefore will not be given further consideration.

The relatively even performance of the linear and conjunctive models in the Ogilvie and Schmitt study may in part reflect individual differences in the ability of decision makers to process information at higher levels. All judges appear to be able to use all information at low (two cues) information levels. When four or more cues were presented, subject differences in ability to simultaneously process information may have resulted in some individuals resorting to a linear strategy while others utilized a conjunctive one. Thus, neither model was superior to the other. Valenzi and Andrews (1973) and Dobmeyer (1970) found considerable individual differences in the weighting of information (both linearly and configurally) by selection interviewers.

The amount of information presented is a characteristic of the situation, but the ability to process information may vary with individuals. In his well-known article, Miller (1956) suggested that span of immediate memory, limits of absolute judgment and a number of other upper limits for cognitive factors might be seven units (plus or minus 2). However, he noted that by heuristics or encoding processes persons can significantly increase their short term memory. Thus, amount of information each subject can handle may vary widely. Only a few college students may have to utilize information reduction models to process eight cues. Another reason for the apparent low usage of the nonlinear models may have been the subjects' ignorance of how those strategies reduce the amount of information. A decision task variable which is less sensitive to individual differences than the amount of information may provide greater support for the use of the conjunctive strategy in decision making.

A second factor, which was hypothesized by Einhorn (1971) to facilitate the use of the conjunctive model, is the cost of a false positive decision. The multiple cut-off approach was designed to protect against that very type of decision error. Where the cost of false positive decision is high, the decision maker searches for negative information (i.e., low cue values), comparing values with minimal cut-off levels to reach a final decision. In Einhorn's job preference study, the cost of choosing a job, which would eventually be unsatisfactory, was assumed to be rather high for subjects. In this situation the conjunctive model was found to be superior to the linear. Here, individual differences in subjects' ability to process information were not apparent as the conjunctive model provided the best fit for subjects' responses across all information quantity conditions. In comparison, Einhorn's (1971) graduate admissions task, where the cost of a false position decision had less personal relevance for the subjects, resulted in relatively equal performance of conjunctive and linear models. Einhorn (1971) further suggested a number of task-related factors which might increase the cost of a false positive decision: involvement of the decision maker, amount of payoff, and familiarity of the decision maker with the task.

Increasing the payoff for the decision makers can increase their involvement in the task. Giving subjects a sum of money and telling them that they will lose a fixed amount for each error should further increase the cost of a false positive decision for them, resulting in greater use of the conjunctive model.

Familiarity is virtually synonomous with experience. All of the studies previously cited in support of nonlinear models (Wiggins & Hoffman, 1968; Kort, 1968; Hoffman, Slovic & Rorer, 1968; Valenzi & Andrews, 1973; and Libby, 1976) used experienced decision makers in the typical context in which they make job-related decisions.

Another study (Miller, 1971) found differences between statisticians and clinicians in their ability to use information in making academic performance predictions. The statisticians relied more on the numerical relationships among cues and criterion while clinicians relied more on verbal labels. Although Miller's study demonstrates that the type of judge studied can make a difference, the decisions made were not typically job relevant, i.e., judges could not be categorized as experts on academic prediction tasks. The removal of labels would most likely alter the context considerably, so that the judges would be more prone to use a linear combination instead.

No comparison has been made of information used by experienced and novice decision makers on the same task. Without any previous exposure, decision makers may be more likely to average the information presented (Brehmer, 1974). Specific configural combinations and the use of nonlinear models would be more likely to occur after the impact of earlier decisions are known. As previously indicated, Hammond and Summers (1965) found that subjects, presumably naive to the decision task, were able to combine information nonlinearly when given outcome feedback and instructions about the nature of the cue criterion relationships. Experienced decision makers get feedback for decisions made on the job and hence may develop nonlinear policies.

Since nonlinear models and the use of specific configural cue combinations have been demonstrated in contexts familiar to the decision makers, the labels given the cues are assumed to be an integral factor in decision making. In these situations would the absence of any cue labels still result in nonlinear combinations? Cue labels would seem to be a vital aspect of Brunswik's (1955) concept of representative design. In an MCPL study, Miller (1971) found that judges used information less consistently when cue labels were absent than when the cue labels were present. The lowest consistency indices occurred where the cues were unlabelled and the values were incongruous (i.e., unlikely negative intercorrelations). Miller did not examine the effects of labels on nonlinear processing.

A number of situational characteristics have been advanced as encouraging the use of nonlinear information combination models. Just as certain features of the decision task can bias information use in favor of nonlinear models, some task characteristics can induce a linear response bias. The Goldberg (1968, 1971) and Dawes and Corrigan (1973) studies, which provide major support to the linear superiority argument, primarily utilized two tasks: a rating based on MMPI profiles and a prediction of performance in graduate school. These two tasks have been used in a number of studies, with many using the same overworked Meehl

(1954) data set. These tasks may contain an inherent linear bias which precludes nonlinearity. A wider variety of tasks should be employed in studying models of decision making to minimize task specific results.

In review, evidence from a number of sources has indicated that the linear model is not the universal model (or perversely pervasive one as Green (1968) termed it) for all human information processing. It may perform well in a number of general situations, but evidence also indicates that nonlinear models may be more appropriate in a number of specific situations.

Therefore, the present research was designed to examine decision making in situations which have been hypothesized to favor the use of nonlinear models, especially the conjunctive model. The factors to be manipulated to create the desired circumstances are (1) the type of judge (novice and expert), (2) cue labels (present and absent), (3) the cost of false positive decisions (high and low cost instructions), and (4) the payoff to judges (monetary payment and nonpayment). Factors 1-3 were systematically varied in one experiment, and factors 2-4 were varied in a second study. It was hypothesized that nonlinear models would be used more frequently by expert judges than novices and that the nonlinear use of cues would be more frequent when labels are present. Likewise, high cost instructions and monetary payment would also result in greater use of nonlinear models.

METHOD

Experiment I

Experimental Design

The experimental design consisted of a 2 (judge type: novice, expert) by 2 (cue labels: present, absent) by 2 (cost of false positive decision instructions: high, low) by 2 (decision models: linear, conjunctive) fixed effects design with repeated measures on the last factor.

Subjects

Ninety-two persons served as subjects in this experiment with at least 10 in each cell. Forty-eight of the subjects, the novice condition, consisted of students in Introductory Psychology classes at Michigan State University. For their participation, they received extra credit towards their final grade.

The additional 44 subjects, those in the expert condition, consisted of recruitment interviewers at the Placement Center at Michigan State University. Interviewers' participation was voluntary. All subjects were randomly assigned to experimental conditions with the exception of the subject variable, type of judge.

Decision Task

Subjects were asked to rate the expected job performance level of 55 job applicants on a ten-point scale, ranging from performs "most duties inadequately" to performs "at the very best in this occupation." The first 15 judgments served as practice trials. The job to be filled was described as "one requiring a reasonable amount of responsibility and contact with people." It was also stated that a bachelor's degree was "typically required" for job entry.

Subjects were presented with six types of numerical information about the applicants. Each source of information was on a scale from one to ten. The values of the cues were assigned by the experimenter so as to suggest nonlinear combination of cues. This was done by assigning one or more cues a low value of one or two. In many cue sets there were also one or more high values, i.e., values of seven or larger. Attempts were made to evenly distribute the high and low values across all information sources, so not to concentrate the low values in specific cues or cue combinations. Even distribution of these values did result in some negative cue intercorrelations as can be seen in Table 1, where the cue intercorrelations are presented.

As seen in Table 1, however, only one negative cue intercorrelation was significant, that between experience and dependability. While in most job situations those two variables are generally unrelated, that particular negative correlation did not prove problematic for the subjects. Although there are many negative intercorrelations, the magnitudes of interrelationship were slight enough so that no subject reported noticing any irregular aspects in the cue sets. The intended positive (but non-significant) correlation between class standing and intelligence was obtained. Data also presented in Table 1 revealed that the means and standard deviations were approximately equal for all

Table 1. Means. Standard Deviations and Intercorrelations Among Cue Values.

Source 1*	1.00					
Source 2	.117	1.00				
Source 3	-.108	-.135	1.00			
Source 4	-.210	-.226**	-.151	1.00		
Source 5	-.112	-.103	-.178	-.100	1.00	
Source 6	-.159	-.188	-.184	-.039	.217	1.00

	Source 1	Source 2	Source 3	Source 4 Oral	Source 5 Class	Source 6
Cue Labels	Dependability	Experience	References	Communication	Standing	Intelligence
Means	5.16	5.24	5.00	5.20	5.07	5.07
Standard Deviations	2.12	2.08	2.18	2.15	2.15	2.18

Note. *Vertical labels were used for the unlabeled condition while labels on the horizontal plane were used in labelled conditions.

**$p < .05$

cue types. All cue values and the job performance scale are presented in Appendix A.

Procedure

A booklet containing instructions, 15 practice applicants, 40 job applicants, and a feedback sheet with manipulation check was given to the subjects. Subjects were asked to read the instructions and then to evaluate the practice candidates first to clarify any questions they might have had on the task. Evaluations were based on the level of job performance the applicants could be expected to attain if they were hired. Subjects were also told that an average applicant would generally have a level of between five and six on each source. After they had an opportunity to ask questions, subjects were then directed to evaluate the 40 applicants. All subjects were instructed to use their judgment, avoid mathematical calculations, and be as accurate as possible.

Instructions were used to manipulate the cue labels and cost of a false positive decision factor. The instructions were shuffled together so distribution of the booklets to subjects would result in random assignment.

For the cue labels factor, half of the subjects were given a description of each of the six cue labels (e.g., dependability, oral communication), and an explanation of how the values were arrived at. These cue labels were printed above the columns in which those cue values appeared. The other half of the subjects received no source description, and cue headings were not labelled. Unlabelled instructions explained that researchers were interested in how information was used, independently of the source.

The two levels of the cost of a false positive decision factor were similarly manipulated through the instructions. The introduction of the low cost instructions indicated that the information did not describe actual college students and that their responses would be used only to study their use of information. This sentence was not present in the high cost instructions. High cost instructions contained an additional paragraph explaining the problems organizations are having with false positive decisions and warning subjects that their "primary focus" should be to avoid making those kinds of decisions.

After evaluating all applicants, subjects were asked to describe how they used the information to reach their decisions. They were also asked to respond to a series of questions on a five point scale. These questions asked for perceived confidence in decisions, ability at making these decisions, degree of concern about those errors, and overall quality of applicants. When finished, subjects were debriefed and dismissed. Full instructions for each condition are reproduced in Appendix B.

Dependent Variables

Multiple correlations describing the relationship between the six information sources and subjects' judgments served as indices of model performance. Multiple correlations obtained from the 40 job applicant trials represented the degree to which a linear model "captures" the judge's rating policy. More specifically, the correlation indicates how consistently the information was weighted and summed in making judgments. This measure is analogous to the consistency index in the usual MCPL study (Dudycha & Naylor, 1966; Schmitt, Coyle & King, 1976).

To assess the degree to which subjects' judgments fit the conjunctive model, nonlinear transformations of the cues and criterion were performed (Einhorn, 1970, 1971). Logarithmic transformations of the cue values and subjects' responses were computed. Then the transformed cue values were regressed on the subjects' responses. Mathematically, the conjunctive model is operationalized by Equation 1. The resulting multiple correlations reflect how consistently subjects used the conjunctive model or multiple cut-off strategy in making their job performance estimates.

Data Analysis

The multiple correlations from each model were then transformed to Fisher Zs to become the primary dependent measure. The Fisher Z values were submitted to a 2 (Judge type - J) by 2 (Labels -L) by 2 (Cost of false positive decision -C) by 2 (Decision Models -DM) fixed effects univariate analysis of variance with repeated measures on the last factor.

The responses to the five questions on the feedback page were submitted to a multivariate analysis of variance to assess the perceived effects of experimental manipulations on the subjects.

To further explore the possibility that subjects may have used alternative decision models, all possible two-way and three-way interaction configural terms were added to each judge's regression equation to see if they would improve predictability. Configural models were developed by first multiplying all possible information cue combinations, taking two and three cues at a time. This procedure resulted in 15 two-cue products and 20 three-cue products. A hierarchical regresssion procedure was then used to test if configural terms were being used by judges in making decisions. The regression procedure employed forced inclusion to enter the six linear terms into the regression equation first. A stepwise inclusion procedure brought in significant two-way interaction terms and then any significant three-way interaction terms.

In this manner significant terms represented increases in the predictability of a subject's decisions beyond that afforded by the simple linear model. Two-term products were included first to keep explanations as parsimonious as possible. Any three cue products had to make unique increments beyond those of any significant two-way terms. Criteria for significant predictors were set at fairly rigorous levels to try to avoid the inclusion of statistically significant predictors which had no practical significance. Configural predictors were required to have significant ($p < .05$) F-ratio to enter the regression equation and in addition had to increase the squared multiple correlation by at least .02. The latter criterion is equal to eta squared, representing at least a 2 percent incremental contribution to the predictable variance in the judges' decision policies.

Experiment II

Experimental Design

The experimental design consisted of a 2 (labels: present, absent) by 2 (cost of false positive decision: high, low) by 2 (payment: \$2.00, \$0.00) by 2 (decision models: linear, conjunctive) fixed effects design with repeated measures on the last factor.

Subjects

Eighty-nine persons originally served as subjects with at least 10 in every cell. Thirty-two subjects were males (four per cell) and the remainder females. All subjects come from Introductory Psychology classes at Michigan State University and received extra credit for their participation. Forty-seven of these subjects also received $2.00 as a feature of the payment condition.

Decision Task

Subjects performed the same expected job performance ratings of 55 job applicants as did the subjects in Experiment I. The same cue values were also utilized.

Procedure

As in Experiment I, subjects were given a booklet of materials and asked to read the instructions. They were told to evaluate the 15 practice applicants, ask questions, and then rate the remaining 40 applicants.

All experimental factors were manipulated via instructions with all instruction conditions shuffled for random assignment. The labels factor was manipulated as in Experiment I. The cost of a false positive decision factor was manipulated as in Experiment I for the low cost condition, but the following two sentences were added to the high cost instructions:

> Your decisions will be evaluated against those of expert interviewers and personnel administrators. Past experience on this task has demonstrated that that those who perform well on the task are good evaluators of human behavior and would make good interviewers.

The addition was made to further increase the involvement and perceived cost of false positive decisions since the manipulation in Experiment I was felt to be somewhat weak. In the nonpayment condition of the payment factor, subjects received no additional instructions. The subjects in the paid condition were told that they had an initial sum of $2.00 but would lose 5¢ for each incorrect decision made in order to increase the cost of a false positive decision.

After completing all forms, the subjects were debriefed and dismissed. In addition, subjects in the payment condition were given two dollars, regardless of their performance on the task. The debriefing procedure for paid subjects consisted of an explanation that there were no right or wrong answers, but that the experimenters were interested in how they used information under conditions in which their decisions might result in financial loss.

Dependent Variables

As in Experiment I, the dependent variables in this study were the multiple correlations between the subjects' judgments and the information cues from both linear and conjunctive models. Subject responses to feedback questions were also treated as dependent measures.

Data Analysis

The multiple correlations from each model were first transformed to Fisher Zs. The transformed values were then submitted to a 2 (Payment - P) by 2 (Labels - L) by 2 (Cost of false positive decision - C) by 2 (Decision Models - DM) fixed effects univariate analysis of variance with repeated measures on the last factor.

The responses to the five questions on the feedback page were submitted to a multivariate analysis of variance to assess the perceived effects of experimental manipulations on subjects.

Configural models were also developed for each decision maker to examine the possibilities that alternative decision strategies were used by judges. As in Experiment I, configural models were developed by adding two-way and three-way interaction terms to the linear model by means of step-wise regression procedures. Similar criteria of a significant *F*-ratio and a 2 percent incremental contribution to the variance were established for configural terms.

RESULTS AND DISCUSSION

Results: Experiment I

Model Consistency Analyses

The means and variances of the Fisher Zs from each cell of the design are presented in Table 2. One subject was deleted from the high cost instruction, unlabelled cues, expert judge condition because he had indicated in his self-report that he had summed the cue values (in violation of the instructions) to reach his judgments. A test for homogeneity of variance on the resulting data demonstrated that the cell variances were relatively homogeneous, $F_{max} = 3.55$, n.s.

The results of the analysis of variance, presented in Table 3, indicated that the linear model, $\bar{Z} = 1.1466$, more consistently accounted for the subjects' use of information than did the conjunctive model, $\bar{Z} = 1.0623$. However, the main effect for models was moderated by the interaction between cost of a false positive decision and models, which is graphically described in Figure 1. Simple effects tests of this interaction revealed that the multiple correlations for the linear model were significantly greater than those for the conjunctive model only when experimental instructions described the cost of a false positive decision as being low, $F\ (1,83) = 19.798$, $p < .001$. With high cost instructions, (HC), the models did not differ, $F\ (1,83) = 1.761$, n.s. Conversely, the significant interaction also demonstrated that the

Table 2. Experiment I: Means, Variances and Cell Sizes.

		Low Cost Instructions			
		Unlabelled		Labelled	
		Linear	Conjunctive	Linear	Conjunctive
	n*	12	12	11	11
Novice	$\bar{X}$	1.0817**	.9213	1.2677	1.1612
	s^2	.0498**	.0429	.0695	.0600
	n	10	10	11	11
Expert	$\bar{X}$	1.1406	.9858	1.3418	1.2369
	s^2	.0848	.0675	.0554	.0481

		High Cost Instructions			
		Unlabelled		Labelled	
		Linear	Conjunctive	Linear	Conjunctive
	n	11	11	14	14
Novice	$\bar{X}$	.9079	.8649	1.1255	1.0899
	s^2	.0832	.0450	.0783	.0675
	n	11	11	11	11
Expert	$\bar{X}$	1.1479	1.1619	1.1598	1.1765
	s^2	.1411	.0917	.0398	.0519

*n = number of subjects per cell.
$\bar{X}$ = cell mean
s^2 = cell variance
**Fisher Z values

Table 3. Experiment I: Analysis of Variance Summary.

Source	df	SS	F
Judge (J)	1	.4871	4.237*
Label (L)	1	1.4763	12.841**
Decision Cost (C)	1	.2563	2.229
J × L	1	.0827	.719
J × C	1	.0571	.497
L × C	1	.0674	.586
J × L × C	1	.0827	.719
Subjects (within groups)	83	9.5427	
Model (M)	1	.3208	16.657**
J × M	1	.0002	.010
L × M	1	.0322	1.673
C × M	1	.1011	5.248*
J × L × M	1	.0059	.305
J × C × M	1	.0000	.000
L × C × M	1	.0000	.001
J × L × C × M			
M × Subjects (within groups)	83	1.5987	
Total	181	14.0947	

Note. *$p < .05$

**$p < .001$

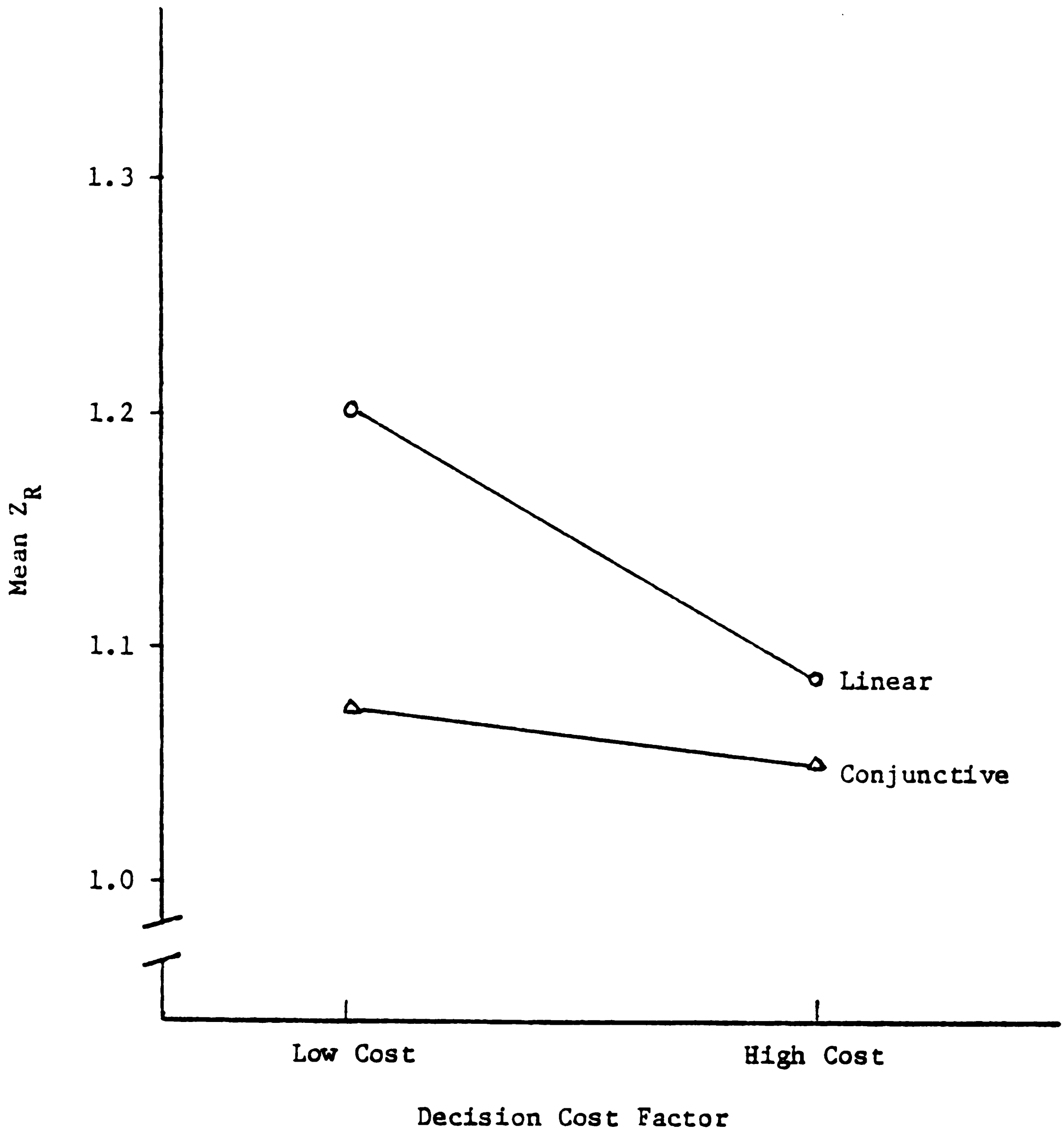

Figure 1. Experiment I: Decision Cost by Model Interaction.

linear model accounted for information use less consistently in the high cost condition than the low cost (LC) condition, $\underline{F}$ (1,83) = 5.097, $\underline{p} < .05$. Instructions did not effect the use of the conjunctive model, $\underline{F}$ (1,83) = .255.

In addition to cost of a false positive decision, other situational variables were found to influence information processing. Significant main effects were obtained for both label and judge factors. Subjects given labelled cues, $\bar{Z}_r$ = 1.1949, were significantly more consistent in using the cue information to make job predictions than were subjects given unlabelled information, $\bar{Z}_r$ = 1.0140, and expert judges, $\bar{Z}_r$ = 1.1564, made decisions more consistent with cue information than did novice judges, $\bar{Z}_r$ = 1.0525. These factors did not interact with each other or with the model factor as predicted.

Perceived Manipulation Effects

To evaluate subject perceptions' of the experimental manipulations, their responses to the questions on the feedback sheet (see Appendix A) were analyzed. The significant manipulation effects are presented in Table 4.

The most perceived differences occurred between types of judges. Expert judges felt they were significantly better at making job selection decisions than novices, and also felt more concerned about making false positive decision errors than did introductory psychology students. Novice judges rated the overall quality of the applicants higher than their experienced counter parts, but an interaction between judges and decision cost moderated that effect with novices rating applicant quality higher only in the low cost condition. Within the interaction,

Table 4. Experiment I: Summary of Perceived Manipulation Effects.

Factor	n	Variable	Means	Univariate F
Judges (J)		How Good*		21.465
	96	Novice	3.17	
	86	Expert	3.81	
		Concern		49.965
	96	Novice	3.37	
	86	Expert	4.19	
		Quality		24.560
	96	Novice	3.16	
	86	Expert	4.19	
Labels (L)		Confidence		6.005**
	88	Unlabelled	3.22	
	94	Labelled	3.54	
Decision Cost (C)		Concern		14.204
	88	Low	3.97	
	94	High	3.54	
J × C		Quality		10.101
	46	Novice,Low	3.35	
	50	Novice,High	2.98	
	42	Expert,Low	2.57	
	44	Expert,High	2.80	

Note. * How good are you at making selection decisions?

** $p < .05$, all other F's $p < .01$.

there were no differences in mean ratings for higher decision costs or expert judges. Thus, high decision cost instructions significantly reduced the novice judges' perception of the quality of the applicants they reviewed, but instructions had no effect on experts' quality ratings.

Differences in perceptions were found between subjects given labelled and unlabelled cues. Those judges making decisions with labelled information cues expressed more confidence in their decisions than those deciding on the basis of unlabelled data only.

The expected differences between levels of the decision cost factor were not obtained on perceptions of how costly false positive decision errors would be for the organization in the study. Thus, the decision cost instructions did not appear to have any measurable effects on perceptions of error cost. Unexpectedly, significant differences were obtained on the concern variable with low decision cost subjects being more concerned than high decision cost judges. This outcome was the opposite of what was expected and was somewhat counter-intuitive.

Configural Models

As an alternative to linear and conjunctive models, configural models were developed for each judge. Configural models included the six cues (as in the linear model) plus any two-way and three-way interaction products which had significant $\underline{F}$ - ratios to enter the regression equation and added 2 percent additional variance to the prediction of job success estimates.

A summary of the configural models along with a comparison of linear and conjunctive models for each judge is listed in Table 5.

Table 5. Experiment I: Linear, Conjunctive and Configural Model Multiple Correlations for all Judges.

Subject	Linear	Conjunctive	Configural	ΔR^2*
Novice, Low Cost, Unlabelled				
1	.870	.846	.890	.034
2	.894	.811	.944	.092
3	.834	.737	.879	.077
4	.865	.797	.883	.031
5	.709	.600	.752	.062
6	.728	.783	.764	.055
7	.783	.691	.820	.060
8	.777	.728	.824	.074
9	.804	.622	.833	.048
10	.584	.522	.646	.076
11	.703	.622	.789	.128
12	.813	.797	.848	.058
Novice, High Cost, Unlabelled				
1	.690	.730	.735	.065
2	.850	.776	.926	.135
3	.857	.769	**	
4	.846	.817	.888	.073
5	.480	.554	**	
6	.703	.703	.781	.116
7	.394	.445	.598	.203
8	.635	.685	.709	.110
9	.663	.537	**	
10	.732	.730	.828	.150
11	.788	.776	**	
Novice, Low Cost, Labelled				
1	.904	.785	.935	.057
2	.805	.784	.832	.045
3	.866	.848	**	
4	.823	.742	.871	.082
5	.915	.854	.934	.035
6	.762	.702	**	
7	.849	.890	.872	.039
8	.895	.902	.934	.071
9	.854	.861	.885	.054
10	.924	.879	.937	.024
11	.617	.602	**	
Novice, High Cost, Labelled				
1	.774	.729	.818	.069
2	.743	.674	.779	.056
3	.791	.627	.848	.093

Table 5. (Cont'd.).

Subject	Linear	Conjunctive	Configural	ΔR^2*
Novice, High Cost, Labelled (cont'd.)				
4	.813	.796	.846	.056
5	.886	.830	.953	.123
6	.858	.822	.895	.065
7	.807	.795	.844	.061
8	.945	.029	**	
9	.905	.831	.920	.027
10	.709	.593	.780	.105
11	.912	.890	**	
12	.865	.847	.888	.040
13	.808	.762	.843	.059
14	.720	.784	.858	.217
Expert, Low Cost, Unlabelled				
1	.746	.660	.782	.056
2	.914	.901	**	
3	.850	.779	.888	.066
4	.681	.702	**	
5	.553	.545	.667	.140
6	.888	.817	.922	.062
7	.860	.819	.893	.059
8	.729	.589	.776	.071
9	.871	.745	.913	.074
10	.840	.808	.948	.194
Expert, High Cost, Unlabelled				
1	.860	.840	.940	.144
2	.856	.827	**	
3	.785	.712	.845	.098
4	.777	.789	.878	.168
5	.414	.436	.630	.226
6	.753	.700	**	
7	.870	.785	.892	.039
8	.665	.659	.727	.086
9	.763	.826	**	
10	.950	.919	**	
11	.918	.881	.932	.027
12	.980	.895	**	
Expert, Low Cost, Labelled				
1	.785	.678	.894	.182
2	.946	.922	**	
3	.841	.799	.863	.038
4	.813	.832	.865	.087
5	.926	.911	.941	.028
6	.824	.831	.854	.050

Table 5. (Con't.d).

Subject	Linear	Conjunctive	Configural	ΔR^2*
Expert, Low Cost, Labelled (cont'd.)				
7	.888	.850	**	
8	.837	.792	.860	.039
9	.917	.891	**	
10	.877	.836	.913	.066
11	.830	.834	.857	.046
Expert, High Cost, Labelled				
1	.913	.849	**	
2	.812	.804	.840	.046
3	.857	.889	.910	.094
4	.768	.786	.844	.124
5	.770	.788	.820	.080
6	.753	.776	**	
7	.779	.757	.818	.063
8	.859	.937	.957	.179
9	.808	.837	.843	.058
10	.890	.832	**	
11	.723	.713	.763	.060

Note. * ΔR^2 = Increment in R^2 obtained by adding configural terms to the Linear model.

** No configural terms meeting specified criteria.

Abundant use of configural models was evidenced in all cells of the experimental design. Overall, configural terms meeting the above criteria were found for 74 percent of the judges (68 of 92). With a more rigorous criterion of a 5 percent increment in the variance in judgment policy accounted for, 56.5 percent (52 of 92) of the judges were still found to utilize configural terms. The mean increment in R^2 for all 68 configural judges were .08363. Configural terms accounted for as much as 22 percent additional variance for one judge.

Thus, considerable use of configurality was evidenced by judges in all categories. The significant linear and configural terms used by each judge are presented in Appendix C. An examination of the use of specific configural terms revealed no clear pattern of cue combination. The most frequently used term was a product of oral communication and intelligence. Five of 21 experts (24%), given labelled cues, relied on that configural term, to make their success estimates.

Discussion: Experiment I

The results of this study did not support the hypotheses that situational factors would lead to increased use of the conjunctive model of information processing. The interaction of decision cost with models was due to the decreased ability of the linear model to account for information use in the high cost condition, and not the improved performance of the conjunctive. Thus, the theoretical and empirical statements of Einhorn (1971) were not supported. The reduced ability of the linear model in the high cost condition was similar to the effect found by Ogilvie and Schmitt (1978) for the amount of information variable. Rather than increasing the use of the conjunctive model, the situational variables amount of information and false positive decision cost have resulted in less consistent use of an averaging or additive model.

A challenge of Einhorn's research is appropriate to the extent that similar variables were tested. Einhorn (1971) used a decision task presumed to have a high false positive cost for decision makers. The present study attempted to vary levels of decision cost via experimental instructions to determine if information use varied across levels. The analyses of perceived decision cost effects yielded inconsistent support for the instruction manipulations. The decision cost variable did not affect cost perceptions, yet information processing was influenced by that variable. In reviewing a number of studies, Nisbett and Wilson (1977) have concluded that subjects have difficulty reporting those factors which affect their responses on tasks involving cognitive activity. Therefore, the decision cost manipulation may have achieved its intended effect despite the failure of subjects to report different levels of perceived cost.

Further support for the manipulation can be obtained from the interaction between judges and cost on the quality variable. In the HC condition, both novice and expert judges rated the quality of applicants at similar levels. All cues were constructed to have one or more low cue values; therefore, the information presented about applicants was somewhat below that of the typical college graduate applicant. Based on their experience, expert judges were evidently more aware of the low values since they rated the overall quality of the applicants lower. In support of the manipulations, the high cost instructions may have made the unexperienced judges more cognizant of the low values since they rated the applicants similarly to the experts in this condition.

The higher concern perceptions in the LC condition are more puzzling. That result may be artifactual and unrelated to any experimental manipulations. However, the results for concern about making decision errors may have a rational basis. Concern self-reports were obtained after the task was completed. HC judges were asked to specifically avoid making decision errors. Having concentrated on that task and followed instructions, they may have been less concerned that they had made those errors. LC judges, who were asked to report their concern for making decision errors after completing a task may then have become more concerned since they may have been casual while making judgments. The reversal could thus represent a type of "Hawthorne effect."

While the type of judge and label variables did not differentially affect model performance as hypothesized, those variables did influence overall information processing in a predictable manner. The type of judge effect confirmed and extended the research of Miller (1971), who found that statisticians and clinicians used information differently. The present study attempted to vary the background and experience of judges on the same continuum. The experienced Placement Center interviewers used the cue information more consistently than the relatively inexperienced introductory psychology students on a decision task relevant to the experience differential.

Several explanations can account for the greater consistency by expert judges. Greater familiarity with the task may have increased attentiveness to numerical cues. Perhaps, specific training or practice making selection decisions enabled experienced interviewers to use information more consistently than novices. On the job they may receive some form of feedback about the outcome of their decisions which helps them to attend to background data carefully. The interviewers also may have viewed the task as more realistic and relevant than introductory psychology students would view them.

The cue label finding confirmed another aspect of Miller's (1971) research, i.e., that the removal of cue labels reduces subjects' ability to consistently use information. This study did not find an interaction between judges and labels as Miller had, but the diversity and orientation of his subjects was greater. The subjects in this study could not be simply dichotomized into verbal and mathematical strategists as could Miller's clinicians and statisticians.

The reported low confidence ratings for unlabelled conditions may provide a theoretical explanation of the cue label effect when viewed relative to Brehmer's (1974) work with ecological hierarchies of functional relationships. He found that in uncertain environments, i.e., low cue-criterion correlations, subjects tried a variety of information utilization rules. The uncertainty generated by unlabelled cues may cause judges to try a variety of decision rules, resulting in lowered consistency values for any one model. The labels may also lead to the development of heuristics or encoding processes as described by Miller (1965), which enabled decision makers to use cue information in a more consistent fashion.

The addition of configural terms resulted in significant improvements in ability to account for information use. Even with strict criteria for the inclusion of configural terms, over half of the judges could be classified as configural. This finding challenges the assertion of Goldberg (1971) that linear models (or perhaps methods) will generally provide as good a fit as any model in most decision situations. Dawes and Corrigan (1974) have also argued that the characteristics of many decision making situations favor linearity. At least this study has provided one context where linearity appears not to be the heavy favorite.

To summarize, the results of Experiment I have shown that situational factors do influence the way in which information is used to make judgments although those factors did not result in greater use of the conjunctive model. Furthermore, the abundance of configurality demonstrated that alternative models can exceed the ability of the linear model to "capture" judges' policies. However, the absence of any pattern in use of specific configural terms limits interpretability. While the specific configural terms may be somewhat spurious, evidence for some type of nonlinear processing was found.

In attempts to provide greater insight into the use of nonlinear models by decision makers in a somewhat different situational context, attention will now focus on the results of Experiment II, which used pay to increase the cost of false positive decision errors and studied novice judges in all conditions.

Results: Experiment II

Model Consistency Analyses

Initial computation of cell means and variances revealed somewhat large discrepancies in cell variances, F_{max} (16,13) = 11.273, p <

.05. The departure from the homogeneity of variance assumption plus unequal cell frequencies would bias resulting $\underline{F}$ tests (Winer, 1971). Since equal cell frequencies make this test relatively robust against homogeneity violations, nine judges were randomly deleted from cells resulting in ten observations per cell. Descriptive statistics on the resulting data are presented in Table 6. The cell variances were not significantly different within this data set, $\underline{F}_{max}$ (16,9) = 7.205.

An analysis of variance treating sex of subject as an independent variable found no differences between males and females on either the dependent variable or any of the manipulation checks. Therefore, the data were combined for subsequent analyses.

The analysis of variance results, combined across sex of subject, are presented in Table 7. The highly significant model effect was moderated by two-way and three-way interactions. The multiple correlations from the linear model ($\bar{Z}$ = 1.1934) were significantly larger than the multiple correlations from the conjunctive model ($\bar{Z}$ = 1.0793). However, the interaction of models with labels and decision costs revealed that the linear model was not always superior.

Simple effects tests of the interaction between labels and models at decision cost levels yielded a significant two-way interaction for low decision costs, $\underline{F}$ (1,72) = 9.593, $\underline{p}$ < .01, and a nonsignificant interaction in the HC condition, $\underline{F}$ (1,72) = .014. Simple main effects tests of the model factor at both levels of the label factor within LC further revealed that the linear model multiple correlations were significantly greater than the conjunctive only in the unlabelled condition, $\underline{F}$ (1,72) = 15.361, $\underline{p}$ < .001. Models did not differ significantly in the labelled, low cost condition, $\underline{F}$ (1,72) = .676. In

Table 6. Experiment II: Means, Variances and Cell Sizes.

		Low Cost Instructions			
		Unlabelled		Labelled	
		Linear	Conjunctive	Linear	Conjunctive
	n*	10	10	10	10
Unpaid	$\bar{X}$	1.279**	.9979	1.1301	1.1297
	s^2	.0521	.0161	.0448	.0658
	n	10	10	10	10
Paid	$\bar{X}$	1.0360	1.1546	1.2165	1.1420
	s^2	.0583	.0665	.0931	.0787

		High Cost Instructions			
		Unlabelled		Labelled	
		Linear	Conjunctive	Linear	Conjunctive
	n	10	10	10	10
Unpaid	$\bar{X}$	1.0270	.8982	1.3182	1.1875
	s^2	.0971	.0465	.1295	.1160
	n	10	10	10	10
Paid	$\bar{X}$	1.2212	1.1147	1.2434	1.1283
	s^2	.0481	.0291	.0298	.1059

*n = number of subjects per cell
$\bar{X}$ = cell means
s^2 = cell variances

**Fisher Z values

Table 7. Experiment II: Analysis of Variance Summary.

Source	df	SS	F
Pay (P)	1	.1879	1.486
Label (L)	1	.4101	3.243
Decision Cost (C)	1	.0057	.045
P × L	1	.2395	1.894
P × C	1	.0000	.000
L × C	1	.1116	.883
P × L × C	1	.1383	1.093
Subjects (within groups)	72	9.1054	
Model (M)	1	.5208	50.258**
P × M	1	.0111	1.067
L × M	1	.0460	4.441*
C × M	1	.0015	.147
P × L × M	1	.0002	.016
P × C × M	1	.0273	2.633
L × C × M	1	.0535	5.165*
P × L × C × M	1	.0005	.052
M × Subjects (within groups)	72	.7461	
Total	159	11.6053	

Note. $*p < .05$

$**p < .001$

addition, the changes in model performance with labelled and unlabelled cues were nonsignificant for both linear and conjunctive models. Figure 2 graphically describes these statistical findings.

Analysis of the simple main effects for labels and models in the HC condition indicated that the linear model yielded higher multiple correlations for both unlabelled, $F\ (1,72) = 13.351$, $p < .01$, and labelled cues, $F\ (1,72) = 14.594$, $p < .01$. Differences between labels at both levels of model were nonsignificant. As depicted in Figure 2, the between model values in HC are different from each other, but the apparent rise in slope from unlabelled to labelled was nonsignificant for both models.

Analysis of the two-way interaction of labels with models yielded an outcome similar to the three-way interaction (see Figure 3). Simple effects tests for differences between models demonstrated that the linear model was significantly better than the conjunctive model at "capturing" subjects' decision policies in both unlabelled, $F\ (1,72) = 42.284$, $p < .001$, and labelled conditions, $F\ (1,72) = 12.411$, $p < .001$. The combination of significant interaction and significant simple effects at both model levels then meant that the difference between models was significantly greater in the unlabelled condition than the difference in the labelled one. Labelling cues resulted in significant improvements for the conjunctive model, $F\ (1,72) = 5.341$, $p < .025$, but not the linear model, $F\ (1,72) = 1.326$.

Perceived Manipulation Effects

Analyses of the subjects' self-reports of experimental manipulation effects yielded no differences on the decision cost variable. On

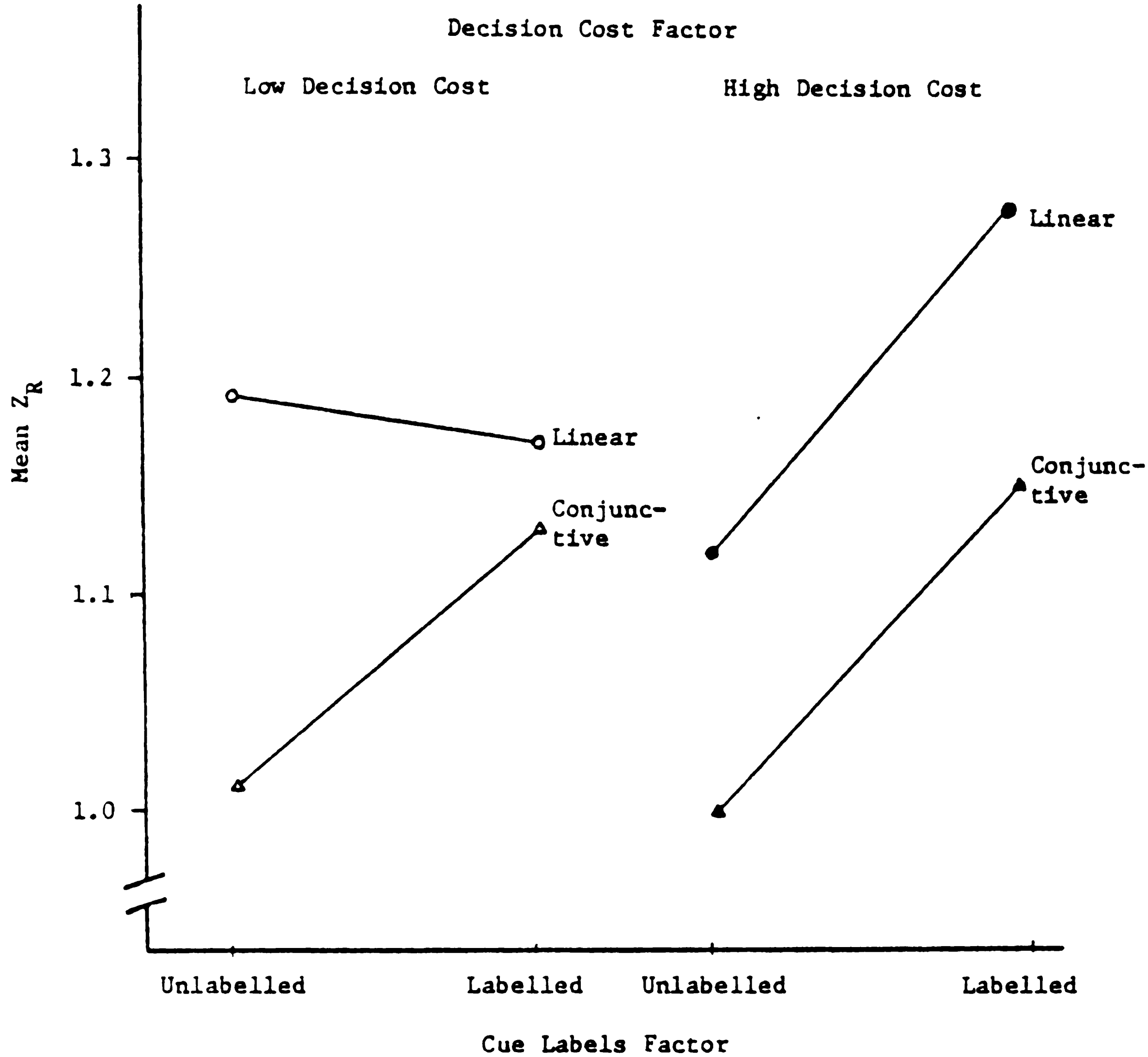

Figure 2. Experiment II: Label by Decision Cost by Model Interaction.

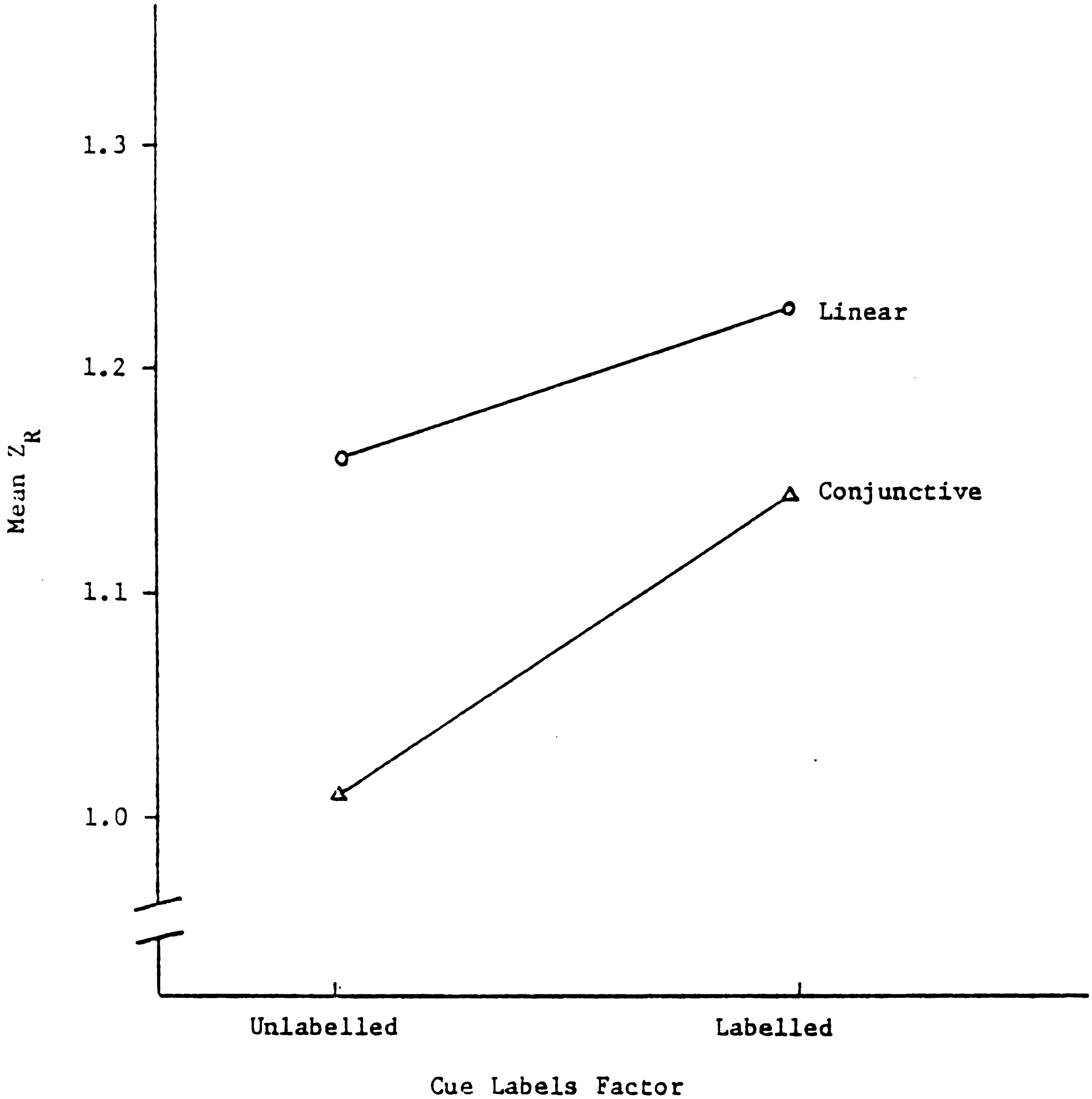

Figure 3. Experiment II: Label by Model Interaction.

the label variable, subjects using labelled cues ($\overline{X}$ = 3.58) were again more confident than those using unlabelled cues ($\overline{X}$ = 3.05). Subjects in labelled conditions ($\overline{X}$ = 3.60) expressed more concern about making false positive decision errors than did subjects in unlabelled conditions ($\overline{X}$ = 2.90). The pay variable yielded the expected difference in perceived cost with paid subjects ($\overline{X}$ = 3.80) viewing decision errors as more costly than unpaid subjects ($\overline{X}$ = 3.28). However, paid judges ($\overline{X}$ = 3.10) were less confident than their unpaid counterparts ($\overline{X}$ = 3.53).

Thus, telling subjects that they would lose 5¢ for each incorrect decision did serve to increase the cost of false positive decision errors, but unexpectedly lowered their confidence in their judgments. Decision cost instructions did not yield any measured differences in perceptions for this study.

Configural Models

As in Experiment I, configural models were developed for each judge by adding two and three-way interaction terms to the regression equation. The same criteria of a significant F to enter the equation and a 2 percent increment in variance accounted for were employed.

The multiple correlations for the linear, conjunctive and configural models are presented in Table 8. Once again a large number of judges' models met the statistical criteria for configurality. Seventy-four percent (66 of 89) of the judges regression equations included configural terms. With a more rigorous statistical criterion of 5 percent incremental variance, 64 percent (57 of 89) of the judges could still be classified as configural. The average increment which configural terms made for all 66 configural judges was a substantial

Table 8. Experiment II: Linear, Conjunctive and Configural Model Multiple Correlations for all Judges.

Subject	Linear	Conjunctive	Configural	ΔR^2*
Unpaid, Low Cost, Unlabelled				
1	.845	.809	.872	.046
2	.859	.796	.928	.123
3	.870	.827	.942	.130
4	.744	.743	.814	.109
5	.797	.716	.851	.089
6	.813	.755	.926	.198
7	.828	.786	**	
8	.705	.673	.812	.162
9	.609	.683	.704	.126
10	.863	.762	**	
Unpaid, High Cost, Unlabelled				
1	.842	.786	**	
2	.562	.513	.642	.096
3	.652	.645	**	
4	.825	.734	**	
5	.890	.837	.925	.063
6	.409	.542	.624	.223
7	.782	.655	**	
8	.809	.709	.886	.131
9	.859	.790	**	
10	.813	.798		
Unpaid, Low Cost, Labelled				
1	.736	.791	.813	.120
2	.697	.751	**	
3	.852	.869	.910	.104
4	.910	.918	**	
5	.706	.648	**	
6	.829	.733	.882	.090
7	.831	.780	.894	.109
8	.768	.800	.799	.049
9	.842	.784	.869	.047
10	.794	.735	.857	.104
11	.881	.904	.937	.102
Unpaid, High Cost, Labelled				
1	.892	.859	.927	.063
2	.927	.868	.947	.036
3	.700	.656	.795	.142
4	.850	.794	**	
5	.845	.795	.927	.146
6	.758	.743	.877	.196
7	.527	.565	.862	.465
8	.875	.771	.938	.114

Table 8. (Cont'd.).

Subject	Linear	Conjunctive	Configural	ΔR^2*
Unpaid, High Cost, Labelled (cont'd.)				
9	.920	.920	.949	.055
10	.892	.859	.923	.056
11	.945	.043	.956	.022
Paid, Low Cost, Unlabelled				
1	.639	.595	**	
2	.689	.661	.853	.253
3	.929	.896	.942	.024
4	.839	.766	.866	.045
5	.922	.851	**	
6	.860	.625	.884	.042
7	.924	.836	.936	.023
8	.879	.821	.895	.029
9	.813	.774	.889	.129
10	.886	.800	.929	.078
11	.874	.815	.889	.028
Paid, High Cost, Unlabelled				
1	.918	.880	**	
2	.864	.802	.934	.127
3	.883	.864	.901	.032
4	.879	.772	.923	.080
5	.774	.829	.879	.175
6	.801	.808	**	
7	.782	.727	.814	.052
8	.877	.841	.914	.066
9	.685	.673	.745	.085
10	.899	.848	.923	.043
11	.829	.786	.903	.128
Paid, Low Cost, Labelled				
1	.817	.753	.929	.196
2	.850	.820	.913	.112
3	.950	.946	**	
4	.813	.768	.845	.053
5	.779	.738	.818	.063
6	.767	.756	.915	.249
7	.644	.670	.874	.349
8	.780	.764	.880	.166
9	.858	.866	.939	.145
10	.834	.783	.910	.133
11	.981	.978	**	
12	.920	.869		

Table 8. (Cont'd.).

Subject	Linear	Conjunctive	Configural	ΔR^2*
Paid, High Cost, Paid				
1	.891	.882	.917	.047
2	.873	.841	.907	.060
3	.771	.785	.835	.103
4	.877	.920	.921	.079
5	.832	.752	.912	.145
6	.882	.884	.943	.112
7	.895	.872	**	
8	.717	.644	.823	.163
9	.798	.724	.862	.107
10	.857	.756	**	
11	.804	.690	.845	.068
12	.849	.744	.899	.088
13	.896	.934	.930	.058

Note. * ΔR^2 = Increment in R^2 obtained by adding configural terms to the Linear Model.

** No configural terms meeting specified criteria.

configural terms made for all 66 configural judges was a substantial 11 percent with the greatest increment for any one judge being 47 percent.

The least number of configural judges per cell, four of ten, were found in the unpaid, high cost, unlabelled condition. When the inclusion criterion was raised from .02 percent to .05 percent increments, six of nine judges in the paid, low cost, unlabelled condition lost their configural designation, indicating that the effects of those configural terms were slight. With the more rigorous criterion, 14 of 32 overall linear judges were in these two unlabelled cue conditions and 21 of 32 linear judges were in all the unlabelled conditions. A chi-square test of the distribution of linear judges (using a .05 criterion) across labelled conditions was marginally significant ($\chi^2 = 3.125$, $p < .10$) with more linear judges in the unlabelled conditions. Other chi-square tests of the distribution of linear judges across labelled and paid conditions were non-significant ($p > .10$) for incremental criteria of .02 and .05.

An examination of the use of specific configural terms in Appendix C did not indicate any dominant pattern of usage. A wide range of cue combinations were used in all cells, both labelled and unlabelled. A slight trend was present in the paid, labelled conditions among three-way interaction terms. Four of the 16 judges with higher interactive terms evaluated the combination of experience, references and oral communication simultaneously when making decisions. Greater use of higher order interactive terms was found in this study with 45 instances of three-way term use as opposed to 24 in Experiment I. As such, there is some evidence that complex decision processes were being used.

Discussion: Experiment II

Overall, the linear model more consistently accounted for the subjects' use of information in making judgments than did the conjunctive model. The superiority was not evident in the labelled, low decision cost condition. Thus, in the LC condition the policy of judges using labelled cues was captured with equal proficiency by both linear and conjunctive models. Although the rise in the performance of the conjunctive model with labelled cues was not statistically significant, it did account for enough additional variance so that it did not differ from the linear. In the two-way interaction involving labels and models, the effect was attributable to a significant rise in conjunctive model performance with labelled cues while performance was constant for the linear. Thus, the hypothesis that cue labels would result in greater use of the conjunctive model was supported.

Cue labels added sufficient information to the decision context so that information was used more consistently with the conjunctive model in making judgments. Miller (1971) had suggested that cue labels represented additional amounts of information in decision making studies. The nature of the information provided by the cues, i.e., specific cue labels, may have facilitated the use of a conjunctive strategy. An alternative explanation is that the conjunctive model was used to reduce the amount of information which was increased by adding cue labels.

However in the HC condition, the superiority of the linear model was maintained in both labelled and unlabelled conditions. HC instructions had been hypothesized to lead to greater nonlinear use of information. As before, the manipulation checks did not reveal any differences on the five feedback items between LC and HC. This outcome was even more unexpected since the cost manipulation was further strengthened in this study to increase the ego involvement of subjects. As in Experiment I, the absence of any perceived effects can be explained by the Nisbett and Wilson (1977) argument that subjects are unaware of the factors influencing their use of information on cognitive tasks. This explanation becomes more plausible here since relevant model effects were found in both studies while subjects were unable to report any perceived cost differences.

The consistent model differences in the HC condition could be attributed to the instructions which told subjects that their score would be compared against experts and that those performing the task well would make good selection interviewers. Presumed to increase ego involvement, these instructions served to uniformly increase performance for both models. The intended ego involvement most likely also created greater task involvement and attentiveness to the cues which resulted in constant differences between models.

In this study the threat of financial loss for making decision errors had no effect on the overall use of information and did not lead to increased use of the conjunctive model as predicted. The analyses of the feedback items helped explain this finding. Subjects receiving pay, $\overline{X}$ = 3.80, did feel that the cost of making false positive decisions was greater than unpaid subjects, $\overline{X}$ = 3.275, indicating the pay factor achieved the intended manipulation result. However, unpaid subjects, $\overline{X}$ = 3.525, were more confident in their decisions than those paid, $\overline{X}$ = 3.10. Interpreting the lack of confidence as uncertainty about which strategy to use then leads to similar explanations as were employed for labels in Experiment I. As Brehmer (1974) suggested, it may be that uncertainty leads to the application of a variety of decision strategies thoughout the task, lowering the consistency of each individual model. Any effect that pay had on increasing conjunctive use may have been offset by the uncertainty. Thus, pay may have had some unintended affects on subjects and may not have provided the best test of the effect of decision cost on information processing.

As in Experiment I, the development of configural models revealed that the majority of decision makers were using information in a complex, configural manner. The somewhat greater use of configural terms in labelled cue conditions in this study implies that configural use may have been meaningful. However, the absence of any consistent use of specific terms, especially with labelled cues, muddles interpretation of the configural effects. The empirical nature of configural models often results in a wide range of model differences, some of which are meaningful and some which are merely statistical artifacts. Without patterns of specific term use, one can not state definitely that the configural terms represent actual decision processes. Nonetheless, these models have provided a clear indication that something more than mere summing or averaging of cue values occurred in this decision context. Goldberg (1971) criticized Einhorn's (1971) work with the conjunctive model on the basis that he did not employ alternative models as a control. If configural models are viewed as a control, then neither the linear nor the conjunctive model may have been used by decision makers in their pure form. More complex decision policies may have been employed by judges to estimate job success.

SUMMARY AND CONCLUSION

This investigation was designed to study the effects of aspects of the decision context on nonlinear information processing. Previous research (Goldberg, 1971; Slovic & Lichtenstein, 1971; Dawes & Corrigan, 1974) had suggested that a linear model would provide a good approximation of how information was used to make decisions in many situations. Empirical support for nonlinear and curvilinear models had been infrequent and limited. Einhorn (1970, 1971) proposed a nonlinear alternative, the conjunctive model, which he hypothesized would represent a more appropriate decision strategy where the cost of false positive decision errors were high.

In two separate experiments, this investigation systematically varied aspects of the decision context which were hypothesized to affect the cost of false positive decision errors and the use of the conjunctive model. The factors predicted to encourage nonlinear information use were experienced decision makers, cue labels, instructions noting the cost of decision errors, and the loss of money for incorrect decisions. The first three factors were varied in the one study while the last three were varied in a second. The effect of these factors on the ability of the linear and conjunctive models to account for the subjects' use of information in making job success estimates of job applicants was studied. As an alternative strategy, configural models were also developed for each judge. The effects of these variables and their implications for information processing are discussed below.

The type and experience of the decision maker affected the use of information. Placement Center interviewers used the information more consistently in reaching their decisions than did introductory psychology students. This result was supportive of previous research and was attributed to the greater familiarity, involvement and training of the experienced judges on the decision task. Future researchers should be aware of the background and experiences of judges when selecting a decision tasks and in generalizing from their results.

Experienced judges did not evidence greater use of nonlinear models; linear models were used more consistently. The decision making experience of the expert judges may have been primarily linear in nature, and so they followed their predominant response tendencies. Thus, they were not as likely to respond to situational manipulations designed to facilitate nonlinear use. Further study of the different types of decision makers could benefit by measuring and attempting to control the type and amount of prior experience that judges possessed.

Although the threat of financial loss served to increase perceptions of the cost of decision errors, the pay variable had no effect on information processing. Paid subjects also felt less confident with their decisions. The uncertainty associated with low confidence was believed to have minimized any potential pay effect. The anxiety and involvement which can accompany conditions of financial loss, especially with college subjects, may render pay a poor means of operationalizing decision cost.

Cue labels were found to have an overall effect of increasing the consistency of information use and were also found to result in greater use of the conjunctive model, supporting one hypothesis and previous research. By providing heuristics or a basis for encoding cue information, the labels facilitated more consistent use of information. The labels may have either provided a specific context for conjunctive use or may have generated enough additional information so that the conjunctive model was needed to reduce the amount. Further work should be done with specific labels and the order of labels utilized.

The final situational factor manipulated was cost of decision errors. In one study high decision costs reduced the performance of the linear model so it did not differ from the conjunctive. In the second study the high cost manipulation was made more ego involving. Here, high costs resulted in linear superiority while in the low cost condition the conjunctive and linear models accounted for information use similarly when cues were labelled. The greater ego involvement may have accounted for the difference between studies.

However, the subjects perceived few, if any, differences between high and low cost situations. While other research has shown that subjects are often unaware of factors influencing their cognitive judgment, the investigator did not feel that decision cost was adequately tested with the instructions employed. This conclusion is especially disconcerting since Einhorn (1971) found the most convincing support for the conjunctive model on a task presumed to have high cost outcomes for decision makers. A more desirable research design is to vary levels of cost within a single experiment as was done here, but the means of operationalizing that variable were inadequate. Thus, the most promising variable for future research with the conjunctive model remains false positive decision costs. In those situations, searches for negative information would occur, which should be best "captured" by the conjunctive model. A selection interview task may provide the needed support for the conjunctive model since reviews have indicated that interviewers search for negative information (Schmitt, 1976).

The poorer overall performance of the conjunctive model leads one to conclude that few people use a conjunctive strategy in combining information to make judgments. The low usage of nonlinear models has been attributed to their complex nature in the past (Brehmer, 1973). Yet the conjunctive model is purported to represent a more simple cognitive strategy. Furthermore, Brehmer (1974) has demonstrated that linear models were the predominant means of describing cue-criterion relationships. Judges may not have used the conjunctive strategy because they were not aware of the ability of a multiple cut-off approach to minimize decision errors. Therefore before disgarding the conjunctive model as useless, further research should be done using learning paradigms, comparing rates of learning and conjunctive relationships with other nonlinear relationships and linear ones. In this manner, both acquisition of knowledge of the conjunctive rules as well as the application of that rule can be studied.

While the conjunctive model performed less well than expected, considerable nonlinear use of information was indicated from the configural models. A great many judges were found to use configural terms (including novice judges). If the configural models are only used as controls, they nonetheless indicate that complex information processing strategies were being used by judges. In fact, neither the conjunctive nor the linear model were probably being used in their pure forms. Instead, more complex models perhaps sequential or combination models, may have been used. The use of configural models in this study supports Goldberg (1971) in urging that control models be employed to provide checks that alternative models are not being used.

The configural abundance in both studies contradicts Green's (1968) comments on the "perverse pervasiveness" of linearity. Configural terms provided a better representation of judgment policies and at times substantially better than the linear terms alone. Therefore, it hoped that this study will begin to dispel some of the notions, fostered by previous research (Goldberg, 1971; Dawes & Corrigan, 1974), that all human judgment is basically linear. The findings of this study may have limited generality due to nature of the decision task utilized. Nonetheless, future research should begin to concentrate on developing more complex, multi-stage models of information processing.

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APPENDICES

APPENDIX A

APPENDIX A

Practice Applicants

To indicate your rating of each applicant, choose the appropriate number from the expected job performance scale below, and write that number in the blank space in the far right column.

The applicant can be expected to perform

1. Most duties inadequately.
2. Many duties at a substandard level.
3. Some duties at a less than satisfactory level.
4. Duties at minimal levels of satisfactory performance, i.e., just get by.
5. All duties at satisfactory levels, but none beyond.
6. All duties acceptably and some above standard.
7. Many duties above standard.
8. Consistently beyond expected standards.
9. At high levels of performance; one of the best in the department.
10. At levels of the very best in this occupation; far exceeding standards.

Person	Dependability	Experience	References	Oral Com.	Class Standing	Intelligence	Rating
A	2	6	7	8	8	4	____
B	7	9	2	5	7	4	____
C	1	4	8	6	5	7	____
D	7	2	3	6	8	10	____
E	6	7	6	4	2	6	____
F	6	5	5	2	6	4	____
G	6	5	4	7	7	2	____
H	6	2	9	4	6	7	____
I	2	7	3	5	9	6	____
J	2	7	3	5	9	6	____
K	9	5	4	6	1	3	____
L	6	6	1	6	5	7	____
M	3	5	5	7	4	2	____
N	7	4	2	6	5	4	____
O	5	4	7	7	2	5	____

Job Applicants

Indicate your evaluation of the following candidates using the scale below.

The applicant can be expected to perform

1. Most duties inadequately.
2. Many duties at a substandard level.
3. Some duties at a less than satisfactory level.
4. Duties at minimal levels of satisfactory performance, i.e., just get by.
5. All duties at satisfactory levels, but none beyond.
6. All duties acceptably and some above standard.
7. Many duties above standard.
8. Consistently beyond expected standards.
9. At high levels of performance; one of the best in the department.
10. At levels of the very best in this occupation; far exceeding standards.

Person	Dependability	Experience	References	Oral Com.	Class Standing	Intelligence	Rating
1	1	4	3	7	7	8	____
2	5	6	5	2	4	3	____
3	7	5	3	8	6	3	____
4	8	1	6	4	9	7	____
5	6	4	7	4	2	6	____
6	6	3	2	9	5	8	____
7	6	8	7	2	7	5	____
8	7	9	2	5	3	5	____
9	5	8	2	6	6	3	____
10	5	7	6	6	2	2	____
11	6	8	7	5	4	3	____
12	9	5	8	8	2	6	____
13	8	6	7	1	6	4	____
14	4	3	6	6	5	1	____
15	2	7	4	7	5	6	____

Indicate your evaluation of the following candidates using the scale below.

The applicant can be expected to perform

1. Most duties inadequately.
2. Many duties at a substandard level.
3. Some duties at a less than satisfactory level.
4. Duties at minimal levels of satisfactory performance, i.e., just get by.
5. All duties at satisfactory levels, but none beyond.
6. All duties acceptably and some above standard.
7. Many duties above standard.
8. Consistently beyond expected standards.
9. At high levels of performance; one of the best in the department.
10. At levels of the very best in this occupation; far exceeding standards.

Person	Dependability	Experience	References	Oral Com.	Class Standing	Intelligence	Rating
16	6	2	5	4	6	4	____
17	5	6	1	4	3	7	____
18	6	9	4	1	5	8	____
19	5	2	5	8	8	4	____
20	2	5	7	9	3	6	____
21	4	4	2	5	5	4	____
22	5	4	6	6	2	7	____
23	1	6	7	5	3	6	____
24	5	4	6	2	5	6	____
25	4	5	5	5	2	5	____
26	4	1	6	6	5	4	____
27	7	6	2	5	4	3	____
28	2	5	4	3	6	8	____
29	8	8	6	7	2	3	____
30	7	6	8	2	6	5	____
31	6	8	2	9	8	10	____

Indicate your evaluation of the following candidates using the scale below.

The applicant can be expected to perform

1. Most duties inadequately.
2. Many duties at a substandard level.
3. Some duties at a less than satisfactory level.
4. Duties at minimal levels of satisfactory performence, i.e., just get by.
5. All duties at satisfactory levels, but none beyond.
6. All duties acceptably and some above standard.
7. Many duties above standard.
8. Consistently beyond expected standards.
9. At high levels of performance; one of the best in the department.
10. At levels of the very best in this occupation; far exceeding standards.

Person	Dependability	Experience	References	Oral Com.	Class Standing	Intelligence	Rating
32	5	2	5	7	4	4	____
33	2	4	4	6	10	7	____
34	9	6	7	5	5	2	____
35	5	6	8	1	7	8	____
36	3	6	9	7	5	2	____
37	8	6	2	3	8	5	____
38	4	7	8	5	6	1	____
39	3	2	5	6	5	8	____
40	4	5	5	5	2	4	____

Before leaving, we would like you to verbally, graphically, or algebraically describe how you used the information to reach your decision. If possible, make it as clear as possible so another person could use your rule with the information and obtain your judgments. (Continue your answer on the back of this sheet if necessary.)

Please respond to the following questions by circling the appropriate response number under each question.

1. How confident were you in your decisions?

1	2	3	4	5
Not Confident		Somewhat Confident		Very Confident

2. In general, how good are you at making these kinds of decisions?

1	2	3	4	5
Poor	Average	Above Average	Good	Very Good

3. How costly would wrong decisions (i.e., people hired who were inadequate for the job) be for the organization in this research project?

1	2	3	4	5
No Costs	Nominal Costs	Somewhat Costly	Costly	Very Costly

4. How concerned were you about making those kinds of wrong decisions?

1	2	3	4	5
Very Unconcerned	Slightly Concerned	Somewhat Concerned	Concerned	Very Concerned

5. Overall, how would you rate the quality of the applicants?

1	2	3	4	5
Far Below Average	Somewhat Below Average	Average	Somewhat Above Average	Far Above Average

Thank you for your assistance.

APPENDIX B

High Cost, Labelled

General Instructions

You are to review the information given you about the applicants and then decide how likely each individual is to succeed on the job if hired. The position to be filled is one requiring a reasonable amount of responsibility and contact with people. A bachelor's degree is typically required for this position, and all applicants are scheduled to graduate this year. (The position is described in general terms so the results can be applied to many occupations.)

In a number of occupations today, the number of applicants is increasing relative to the number of available positions. With this trend, organizations are still making many less than desirable selections. A number of candidates appraised as likely to succeed have not worked out. These false positive mistakes are rather expensive, due to high training costs and the costly errors made on the job. Therefore, in reviewing the following applicants, please carefully evaluate each to insure that no "wrong" decisions are made. Your primary focus should be to avoid the selection of candidates who might not work out.

Based on previous studies, six pieces of information have been identified as being valuable in making job selection decisions. Each source of information will be placed on a ten-point scale. A value of 10 represents a large quantity or very high performance level while a value of 1 represents very low amounts or levels. The average person would generally possess a level of between five and six for each source. The sources of information are listed below. Each value was determined by at least two interviewers or reviewers.

(1) Dependability: a rating based on inquiries into previous work experiences that the applicant had.
(2) Career-related experience: a rating based on the previous jobs and other experience that the applicant had.
(3) Letters of reference: a rating based on three letters of reference supplied by the applicant.
(4) Oral communication: a rating based on the applicant's ability to communicate during an interview.
(5) Scholastic standing: a number representing the decile standing of the applicant in her/his class (e.g., a 7 means the 70th percentile level).
(6) Intelligence: a rating of the mental ability of the applicant based on an interview.

On the following pages will be presented the information for 40 applicants. Before evaluating the 40 applicants, you will be given the opportunity to practice on 15 additional applicants. You are to examine the information for each applicant individually, and then to rate the person's expected level of job performance on a ten-point scale, ranging from "inadequate" to "one of the very best in this occupation." Assume equal gradations of performance between each interval on the scale. The scale will be presented on each page for your convenience. In making your ratings, please refrain from mathematical calculations. Use your judgment to decide how likely each applicant is to succeed. Please be as accurate as possible.

Please turn the page and make your decisions for the practice applicants. Use the trials to see if you have any questions about the task. If you have no questions, proceed to evaluate the 40 actual applicants.

Low Cost, Labelled

General Instructions

You are to review the information given you about the applicants and then decide how likely each individual is to succeed on the job if hired. The information does not represent material from actual college students, and your responses will only be used to study your use of the information. The position to be filled is one requiring a reasonable amount of responsibility and contact with people. A bachelor's degree is typically required for this position, and all applicants are scheduled to graduate this year. (The position is described in general terms so the results can be applied to many occupations.)

Based on previous studies, six pieces of information have been identified as being valuable in making job selection decisions. Each source of information will be placed on a ten-point scale. A value of 10 represents a large quantity or very high performance level while a value of 1 represents very low amounts or levels. The average person would generally possess a level of between five and six for each source. The sources of information are listed below. Each value was determined by at least two interviewers or reviewers.

(1) Dependability: a rating based on inquiries into previous work experiences that the applicant had.

(2) Career-related experience: a rating based on the previous jobs and other experiences that the applicant had.

(3) Letters of Reference: a rating based on three letters of reference supplied by the applicant.

(4) Oral communication: a rating based on the applicant's ability to communicate orally during an interview.

(5) Scholastic standing: a number representing the decile standing of the applicant in her/his class (e.g., 7 means 70th percentile level).

(6) Intelligence: a rating of the mental ability of the applicant based on an interview.

On the following pages will be presented the information for 40 applicants. Before evaluating the 40 applicants, you will be given the opportunity to practice on 15 additional applicants. You are to examine the information for each applicant individually, and then to rate the person's expected level of job performance on a ten-point scale, ranging from "inadequate" to "one of the very best in this occupation." Assume equal gradations of performance between each interval on the scale. The scale will be presented on each page for your convenience. In making your ratings, please refrain from mathematical calculations. Use your judgment to decide how likely each applicant is to succeed. Please be as accurate as possible.

Please turn the page and make your decisions for the practice applicants. Use the trials to see if you have any questions about the task. If you have no questions, proceed to evaluate the 40 applicants.

APPENDIX C

APPENDIX C

Significant Cues Used by Judges in Making Decisions

EXPERIMENT I

	Linear Terms						Two-Way Configural Terms															Three-Way Configural Terms																				
Subject	1	2	3	4	5	6	12	13	14	15	16	23	24	25	26	34	35	36	45	46	56	123	124	125	126	134	135	136	145	146	156	234	235	236	245	246	256	345	346	356	456	
Novice, Low Cost, Unlabelled																																										
1	x	x	x	x	x	x																						x														1
2	x	x	x	x	x	x												x	x																							2
3	x	x	x	x	x	x	x													x																						3
4	x	x	x	x	x	x																				x																4
5	x	x	x	x	x	x		x																																		5
6	x	x	x	x		x																																			x	6
7	x	x		x	x	x														x																						7
8	x	x	x	x	x	x												x																								8
9	x	x	x	x	x	x							x																													9
10	x			x													x																									10
11	x	x	x	x		x					x																										x					11
12	x	x	x	x	x	x			x																																	12
Novice, High Cost, Unlabelled																																										
1	x		x	x		x																				x																1
2	x	x	x	x	x	x		x			x		x																													2
3	x	x	x	x	x	x																																				3
4	x	x	x	x	x	x									x																											4
5				x																																						5
6	x	x	x	x	x									x			x																									6
7						x																					x							x								7
8	x		x	x		x																										x										8
9	x	x				x																																				9
10	x	x	x	x		x			x																		x															10
11	x	x	x	x	x																																					11
Novice, Low Cost, Labelled																																										
1	x	x		x	x		x						x																													1
2	x	x		x	x		x																																			2
3	x	x	x		x	x																																				3
4	x	x	x	x	x													x			x																					4
5	x	x	x	x	x	x						x																														5
6	x	x		x	x	x																																				6
7	x			x		x									x																											7
8	x	x	x		x	x							x		x		x																									8

Subject	1	2	3	4	5	6	12	13	14	15	16	23	24	25	26	34	35	36	45	46	56	123	124	125	126	134	135	136	145	146	156	234	235	236	245	246	256	345	346	356	456	
	Linear Terms						Two-Way Configural Terms															Three-Way Configural Terms																				
Novice, Low Cost, Labelled (cont'd.)																																										
9	x		x	x												x																										9
10	x			x		x										x																										10
11				x	x																																					11
Novice, High Cost, Labelled																																										
1	x			x		x			x																																	1
2	x	x				x	x																																			2
3	x		x	x	x	x				x										x																						3
4	x	x										x																														4
5	x	x	x		x			x		x										x	x																					5
6	x	x						x								x																										6
7	x					x											x																									7
8	x		x	x																																						8
9	x		x			x																														x						9
10	x					x													x																							10
11	x			x		x																																				11
12	x	x	x	x	x	x																						x														12
13	x	x		x		x					x																															13
14	x	x		x		x			x										x				x															x				14
Expert, Low Cost, Unlabelled																																										
1	x	x	x	x	x	x												x																								1
2	x	x	x	x	x	x																																				2
3	x	x	x	x	x	x										x																										3
4	x			x																																						4
5			x																									x														5
6	x	x	x	x	x	x									x				x																							6
7	x	x	x	x	x	x										x																										7
8	x		x	x		x																																		x		8
9	x	x	x	x	x	x																	x														x					9
10	x	x	x		x	x		x		x					x		x																									10
Expert, High Cost, Unlabelled																																										
1	x	x	x	x	x	x	x						x				x				x																					1
2	x	x	x	x	x	x																																				2
3	x	x		x								x				x																										3
4	x	x	x	x	x	x															x			x															x			4
5		x																										x													x	5
6	x		x	x	x	x																																				6
7	x	x	x	x	x	x									x																											7
8	x	x	x	x	x											x																										8

Subject	1	2	3	4	5	6	12	13	14	15	16	23	24	25	26	34	35	36	45	46	56	123	124	125	126	134	135	136	145	146	156	234	235	236	245	246	256	345	346	356	456	
	Linear Terms						Two-Way Configural Terms															Three-Way Configural Terms																				
Expert, High Cost, Unlabelled (cont'd.)																																										
9	x		x	x	x	x																																				9
10	x	x	x	x	x	x																																				10
11	x	x	x									x																														11
12	x	x	x	x	x	x																																				12
Expert, Low Cost, Labelled																																										
1	x		x	x	x	x											x			x	x																					1
2	x	x	x																																							2
3	x	x																										x														3
4	x		x				x			x																																4
5	x			x		x			x																																	5
6	x			x		x																							x													6
7	x			x	x	x																																				7
8	x		x	x		x					x																															8
9	x					x																																				9
10	x			x																	x			x																		10
11	x			x		x														x																						11
Expert, High Cost, Labelled																																										
1	x	x		x	x	x																																				1
2	x	x		x	x	x		x																																		2
3	x	x		x										x		x													x													3
4	x		x			x							x							x																						4
5	x		x	x	x	x																													x							5
6	x	x	x	x	x	x																																				6
7	x		x			x																			x																	7
8	x			x			x		x		x				x				x																							8
9	x		x	x		x														x																						9
10	x	x	x	x																																						10
11	x			x		x														x																						11

EXPERIMENT II

Subject	1	2	3	4	5	6	12	13	14	15	16	23	24	25	26	34	35	36	45	46	56	123	124	125	126	134	135	136	145	146	156	234	235	236	245	246	256	345	346	356	456	
Unpaid, Low Cost, Unlabelled																																										
1	x	x	x	x	x	x														x																						1
2	x	x	x	x	x	x	x					x									x																			x		2
3	x	x	x	x	x	x			x										x	x																						3
4	x	x	x	x	x										x										x																	4
5	x	x	x	x	x	x																												x		x						5
6	x	x	x	x	x	x			x			x			x																x							x				6
7	x	x	x	x	x	x																																				7

	Linear Terms						Two-Way Configural Terms															Three-Way Configural Terms																				
Subject	1	2	3	4	5	6	12	13	14	15	16	23	24	25	26	34	35	36	45	46	56	123	124	125	126	134	135	136	145	146	156	234	235	236	245	246	256	345	346	356	456	
Unpaid, Low Cost, Unlabelled (cont'd.)																																										
8	x			x		x							x																		x											8
9	x			x							x																															9
10	x	x	x	x	x	x																																				10
Unpaid, High Cost, Unlabelled																																										
1	x	x	x	x	x	x																																				1
2	x	x		x																						x																2
3	x	x	x	x	x	x																																				3
4	x	x	x		x	x																																				4
5	x	x	x	x	x	x							x													x																5
6																							x				x															6
7	x	x	x	x	x	x																																				7
8	x	x	x	x	x	x							x								x																	x				8
9	x	x	x	x	x	x																																				9
10	x	x	x	x	x	x																																				10
Unpaid, Low Cost, Labelled																																										
1	x					x	x										x																									1
2	x		x		x	x																																				2
3	x					x					x			x																												3
4	x		x		x	x																																				4
5	x	x	x	x																																						5
6	x	x	x	x		x							x																												x	6
7	x	x		x		x									x																					x						7
8	x	x										x																														8
9	x			x		x																								x												9
10	x		x			x		x																																		10
11	x					x					x									x																			x			11
Unpaid, High Cost, Labelled																																										
1	x			x	x																							x						x								1
2	x			x	x	x												x																								2
3	x		x	x		x										x													x													3
4	x	x		x	x	x																																				4
5	x	x				x								x			x		x																							5
6	x	x	x				x		x					x																												6
7										x			x			x			x									x														7
8	x	x	x	x	x	x				x								x		x																						8
9	x	x		x			x										x																									9

	Linear Terms						Two-Way Configural Terms															Three-Way Configural Terms																				
Subject	1	2	3	4	5	6	12	13	14	15	16	23	24	25	26	34	35	36	45	46	56	123	124	125	126	134	135	136	145	146	156	234	235	236	245	246	256	345	346	356	456	
Unpaid, High Cost, Labelled																																										
10	x	x	x	x	x	x																										x										10
11	x	x	x																x																							11
Paid, Low Cost, Unlabelled																																										
1	x																																									1
2	x	x	x	x		x	x										x															x										2
3	x	x	x	x	x	x																																	x			3
4	x	x	x	x	x	x																															x					4
5	x	x	x	x	x	x																																				5
6	x	x	x	x	x	x		x																																		6
7	x	x	x	x	x	x											x																									7
8	x	x	x	x	x	x			x																																	8
9	x	x	x	x	x	x								x							x																					9
10	x	x	x	x	x	x	x		x																							x										10
11	x	x	x	x	x	x			x																																	11
Paid, High Cost, Unlabelled																																										
1	x	x	x	x	x	x																																				1
2	x	x	x	x	x	x				x			x			x	x																									2
3	x	x	x	x	x	x											x																									3
4	x	x	x	x	x	x							x								x	x																				4
5	x	x	x	x		x									x						x													x								5
6	x	x	x	x	x	x																																				6
7	x	x	x	x	x	x							x																													7
8	x	x	x	x	x	x														x	x																					8
9			x			x										x																										9
10	x	x	x	x	x	x																	x																			10
11	x	x	x	x	x	x	x												x																				x			11
Paid, Low Cost, Labelled																																										
1	x			x		x		x	x											x	x											x										1
2	x			x		x		x	x																																	2
3	x	x	x	x	x	x																																				3
4	x	x	x	x		x				x																																4
5	x	x		x		x																																			x	5
6	x	x	x	x	x	x				x		x	x	x							x																					6
7	x										x		x			x	x											x														7
8	x			x					x																									x								8
9	x			x		x					x			x																		x										9

	Linear Terms						Two-Way Configural Terms															Three-Way Configural Terms																				
Subject	1	2	3	4	5	6	12	13	14	15	16	23	24	25	26	34	35	36	45	46	56	123	124	125	126	134	135	136	145	146	156	234	235	236	245	246	256	345	346	356	456	
Paid, Low Cost, Labelled																																										
10	x	x	x	x	x	x												x			x																					10
11		x																																								11
12	x	x	x			x																																				12
Paid, High Cost, Labelled																																										
1	x		x	x	x	x																					x											x				1
2	x	x	x	x													x																					x				2
3	x					x															x																	x				3
4	x	x	x			x					x					x		x																								4
5	x	x	x	x	x	x				x																				x		x										5
6	x	x	x	x	x	x			x		x						x																						x			6
7	x		x	x	x	x																																				7
8					x											x										x																8
9	x	x	x	x	x	x																			x											x						9
10	x	x	x		x	x																																				10
11	x	x		x	x	x			x																																	11
12	x	x	x	x	x	x													x													x										12
13	x			x					x																																	13