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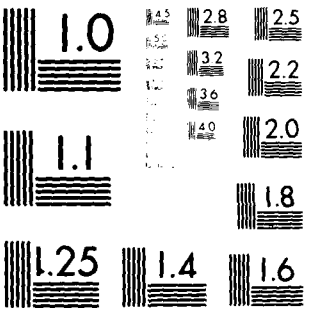

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Contingent Decision Behavior:

A Review and Discussion of Issues

John W. Payne

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A question of great concern in decision research is the extent to which the strategies used by an individual in making a judgment or choice are invariant across task environments. This paper review research showing that information processing in decision making, as in other areas of cognition, is highly contingent upon the demands o the task. Theoretical frameworks for handling task and context effe are explored: (1) Cost/benefit principles; (2) Perceptual processes; and (3) Adaptive production systems. Both the cost/benefit and

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perceptual frameworks are shown to have strong empirical support. Both frameworks, however, also have unresolved conceptual problems that are discussed. The adaptive production system framework has less direct support, but has the desirable property that it contains elements of both of the other frameworks. The question of how the different theoretical frameworks might be integrated is explored.

Abstract

A question of great concern in decision research is the extent to which the strategies used by an individual in making a judgment or choice are invariant across task environments. This paper reviews research showing that information processsing in decision making, as in other areas of cognition, is highly contingent upon the demands of the task. Theoretical frameworks for handling task and context effects are explored: (1) Cost/benefit principles, (2) Perceptual processes, and (3) Adaptive production systems. Both the cost/benefit and perceptual frameworks are shown to have strong empirical support. Both frameworks, however, also have unresolved conceptual problems that are discussed. The adaptive production system framework has less direct support, but has the desirable property that it contains elements of both of the other frameworks. The question of how the different theoretical frameworks might be integrated is explored.

Contingent Decision Behavior:
A Review and Discussion of Issues

It has been recognized that an essential aspect of attempts to improve human decision making is understanding how individuals make decisions. Consequently, much current research attempts to identify the cognitive processes underlying judgment and choice (cf. Einhorn & Hogarth, 1981). A question of great concern in that research is the extent to which the cognitive processes employed by a given individual will be invariant across task environments. Increasingly, the answer to that question seems to be that information processing in decision making, as in other areas of cognition, is highly contingent upon the demands of the task. In the words of Einhorn and Hogarth (1981):

> "the most important empirical results in the period under review have shown the sensitivity of judgment and choice to seemingly minor changes in tasks." [p.61]

The lack of invariance across tasks that are seemingly similar, e.g., choice vs. bidding for the same gambles, is of concern to decision analysts and others whose job is to improve decision performance. Thus, for those decision scientists who prescribe various techniques, the lack of invariance at the least raises questions about the validity of the judgmental inputs needed to make the normative procedures operational. The lack of invariance also complicates the search for a small set of underlying principles that can describe observed behavior.

The present paper has two purposes. First, it provides a selective survey of the research showing the effects of task and context variables on

decision behavior. Second, and more importantly, the paper evaluates alternative explanations of task and context effects. Three theoretical frameworks are explored: (1) Cost/benefit principles and the idea of a meta-level decision process (Beach & Mitchell, 1978; Einhorn & Hogarth, 1981; Russo & Dosher, Note 1), (2) Perceptual principles (Tversky & Kahneman, 1981), and (3) Production systems and adaptive learning (Newell & Simon, 1972; Pitz, 1977). The paper is organized as follows. First, the three theoretical frameworks are briefly described. Next, a review of the empirical research on task effects is provided. A more general discussion of issues associated with the different theoretical frameworks is then presented. The paper concludes by exploring how the different frameworks might be integrated.

THEORETICAL FRAMEWORKS

Cost/Benefit Principles

An obvious possibility for why a decision maker decides to use a particular decision strategy in a specific task environment is that rule selection is the result of a cost/benefit analysis. The idea is that any decision strategy has certain benefits associated with its use and also certain costs. The benefits would include the probability that the strategy would lead to a "correct" decision, speed of decision, and its justifiability. Costs might include the information acquisition and the computational effort involved in using the strategy. Decision rule selection would then involve a consideration of both the costs and benefits associated with each possible strategy. Recent papers by Beach and Mitchell (1978) and Russo and Dosher (Note 1) have argued strongly for the idea that strategy selection is the result of a comparison between the desire to make a correct decision and the

desire to minimize effort.

In the Beach and Mitchell paper this concept is most completely developed. They identify categories of decision strategies running from analytic strategies, such as subjective expected utility maximization, to non analytic strategies, such as flipping a coin or just repeating a previous response. The range of strategies is seen to differ primarily on two dimensions: (1) differences in the amount of resources required to use each strategy, and (2) differences in the ability of each strategy to produce an "accurate" response. A model is then constructed that relates the value of a correct decision and the costs of applying various decision strategies to the following eight variables: unfamiliarity or novelty of the decision task, ambiguity of goals, complexity, instability in task structure, irreversibility of response, significance of outcomes, accountability, and time and money constraints. It is assumed that the decision process selected will be the one that maximizes the expected benefits of a correct decision, e.g., significance, against the cost of using the process. The combination of benefit and cost considerations is assumed to follow a additive rule. Christensen-Szalanski (1978) states that one should not assume that decision makers consciously make <u>all</u> the computations implied by the Beach and Mitchell model. However, he later indicates that decision makers do consciously "consider the potential payoffs and costs of engaging in various acts."

Russo and Dosher also explicitly note that the selection of strategies is a "deliberate" process. In addition, they argue that the tradeoff between error and effort is the reason that people often use a simple dimensional processing strategy when faced with binary choice problems. Further, they suggest that the desire to minimize effort may be a stronger factor than the desire to minimize error. Finally, Russo and Dosher speculate that in tasks

taking more than a few seconds to complete, subjects will monitor their effort expenditures and adjust their strategies accordingly.

Meta-level decisions. An extension of the cost/benefit idea suggested by Einhorn and Hogarth (1981) is that each decision strategy be viewed as a multidimensional object. The dimensions would reflect the costs and benefits used by a decision maker to evaluate strategies. Some possible dimensions are (1) the probability of error, (2) the size of error, (3) speed of decision, (4) justifiability, (5) computational effort, (6) search costs, and (7) awareness of conflict. The various dimensions have all been suggested as determinants of decision making. One could then ask questions such as "which dimensions are most important in selecting a strategy?" "Is strategy selection a compensatory or noncompensatory process?" "To what extent are strategies selected only at the beginning of a decision process or at multiple points during the process?" Furthermore, the multi-level framework could be extended to incorporate uncertainty. Many of the benefits and costs associated with using a particular strategy can only be estimated, as suggested by Beach and Mitchell (1978). This is particularly true in decision situations which are dynamic. Consider the following decision example: You are faced with a large set of alternatives and have to select one. Because the task is complex, you decide to employ a cognitively less costly elimination-by-aspects strategy. Unfortunately, just as you have reached a decision, you are told that your chosen alternative is no longer available. What do you do next? Do you start an EBA process over again? It would probably be preferable to just select the next preferred alternative. However, the idea of next preferred alternative implies a ranking of alternatives which an elimination process does not necessarily provide. It may be that if a possibility exists that a preferred alternative may become

unavailable, a decision maker's expected effort would be less using a more compensatory strategy from the beginning. Such a strategy would allow the identification of a "next best" alternative.

The idea of strategy selection as a higher level decision problem involving consideration of costs and benefits is an appealing framework for considering task effects and contingent processing behavior. It is also a framework that can easily be traced back to early decision research by Simon (1955) and Bruner, Goodnow, and Austin (1956). Other possible frameworks, however, have been suggested. Instead of postulating a higher order decision process; these approaches explain contingent decision behavior in terms of more basic perceptual and stimulus-response types of systems.

A Perceptual Viewpoint

Some of the most dramatic demonstrations of the lack of invariance in human choice behavior, to be discussed later, have been offered by Kahneman and Tversky (1979) and Tversky and Kahneman (1981). They acknowledge that contingent processing in decision making could sometimes be explained in terms of a mental effort construct. However, they prefer to trace such behavior to basic principles governing human perception. Consider, for example, how Kahneman and Tversky (1979) handle the question, why do people appear to code outcomes as gains or losses as opposed to final wealth positions? An economic analysis of choice argues for treating outcomes in terms of final wealth positions. They suggest that since our perceptual apparatus is attuned to the evaluation of changes or differences rather than to the evaluation of absolute magnitudes, it makes sense that an early process of choice would be the coding of outcomes as being either gains or losses relative to some neutral reference point (Kahneman & Tversky, 1979). Furthermore, risk aversion for gains and

risk seeking for losses is seen as a consequence of the fact that monetary changes, like "many sensory and perceptual dimensions share the property that the psychological response is a concave function of the magnitude of physical change [p. 278]".

In their work on the framing of decisions, Tversky and Kahneman (1981) continue their use of perceptual metaphors. In that paper the effects of frames on preferences are compared to the effects of perspectives on perceptual appearances. They note that an important implication of the perceptual metaphor is that subjects "are normally unaware of alternative frames and of their potential effects on the relative attractiveness of options [p. 457]." This represents a major difference between the perceptual framework of Tversky and Kahneman and the error/effort ideas of Mitchell and Beach (1978) and Russo and Dosher (Note 1).

The theory of choice discussed in Kahneman and Tversky (1979) and Tversky and Kahneman (1981), called prospect theory, distinguishes two phases in the choice process: an initial phase in which the problem is edited into a simpler representation and a subsequent phase of evaluation. An example of an editing operation is the coding of outcomes. The evaluation phase consists of a generalized expected utility rule. It is the editing phase that is seen as the primary source of context effects in decision making. The idea is that the same offered set of options might be edited in different ways depending on the context in which it appears. Once the editing phase is completed, however, the basic evaluation process is assumed to be invariant across representations. Thus, one does not really have a selection among choice strategies with the Tversky and Kahneman framework, but different outputs from a single evaluation process depending on the edited representation that inputs into the process.

The perceptual framework raises an important question concerning how the perceptual/decision responses have developed. That is, to what extent are the responses we observe due to basic processes that may be "hardwired" into the human organism via evolutionary processes? The statements by Tversky and Kahneman regarding the fact that people are normally unaware of framing effects, and further, often do not know how to resolve inconsistencies in judgment when they are made aware of them, suggests that the responses are to some extent hardwired into the system. An implication of this view would seem to be that task effects, like perceptual types of illusions, will tend to be universal across subjects. Finally, the perceptual framework implies that incentives are not as likely to influence task or context effects as is the case with a cost/benefit framework.

Production Systems

Pitz (1977) has also questioned the use of effort/error concepts to explain contingent processing. Instead, he suggests the development of rule based theories of decision behavior. In particular, he has suggested modeling behavior in the form of a system of productions (Newell & Simon, 1972). A production is simple a condition → action pair that is similar to the old idea in psychology of a stimulus-response pair. If the conditions of a production are satisfied then the action is taken. A decision production might be as simple as the following comparison operator:

[P1] If you have the values of two alternatives on the same attributes then compare values and note which alternative has the preferred value.

The set of productions possessed by a decision maker can be thought of as being part of long-term memory. The conditions of the productions are tested

against data elements contained in a working or short-term memory. The testing of the conditions of a production is assumed to be automatic. That is, there is "no conscious consideration of which productions to apply [Pitz, 1977, p. 411]." Conscious processing in the rule based theory consists only of the actions that are associated with the productions.

Productions are often assumed to be arranged in an ordered priority list. The conditions of each production are then tested from the top of the list down. As soon as the conditions are satisfied, the associated action is taken. Testing of conditions is then often assumed to start over again from the top. This means, of course, that lower ordered productions will be evoked only if none of the higher productions are satisfied. It is the ordering of productions that is assumed to represent the control mechanism for behavior. Other ideas on the control of production systems are discussed in Newell (1980).

A more complete discussion of the value of production systems as a representation of human cognitive processes is provided by Newell (1980). Two interrelated points, however, need to be mentioned. First, the production system framework is very general. Aspects of both the cost/benefit and perceptual frameworks could be represented by a production system. The question would then become, what are the factors that go into the condition part of the productions? Do they, for example, include error and effort considerations? Second, the generality of production systems also means that specific decision rules certainly can be programmed using a production type of computer language. What counts in evaluating a production system representation of decision strategies is the nature of the mapping. Does the mapping, i.e., the program components, seem plausible given our general knowledge of human cognitive capabilities?

While it is very general, there are differences between the production system framework and the cost/benefit and perceptual frameworks. For example, the degree of awareness of strategy selection is greatest with the cost/benefit framework. One could also compare the developmental or learning assumptions of the frameworks. For instance, the kinds of adaptive production systems that have been suggested, e.g., Anzai & Simon, (1979), seem to be very individual history based. An implication is that production systems would exhibit large individual variability in response to a particular task environment. The perceptual framework, on the other hand, suggests more universal responses across subjects.

Additional issues associated with these theoretical frameworks will be discussed later. For now, let us turn to a review of the empirical evidence supporting the general finding of contingent processing in decision making.

LITERATURE REVIEW

Before reviewing the literature, several points of view need to be made explicit. First, the terms "context effects" and "task effects" have often been used interchangeably in the literature. For the purposes of this review, the following distinction will be made: task effects will be used to describe those factors associated with the general structural characteristics of the decision problem. A partial list of such factors includes: response mode, number of alternatives, number of outcomes, time pressures, presentation mode, and agenda constraints. The term context effects, on the other hand, will be used to describe those factors associated with the particular values of the objects in the decision set under consideration. Examples are the significance of outcomes, the overall attractiveness of alternatives, and the presence of a "ruinous" loss. Context factors have the property that the

values of such factors are more dependent than task factors on individual perceptions. As we shall see, the distinction between task and context factors may also be related to the more general question of when the effort/error or perceptual framework will be valid. Of course, any given decision situation will include both task and context factors.

Next, the paper will adopt the view of decision making as consisting of three interrelated subprocesses (Einhorn & Hogarth, 1981): information acquisition, evaluation/action, and feedback/learning. This perspective will be used to distinguish between those task and contextual influences that result in a change in the salience or attention paid to information in the environment and those that result in changing the decision rule used to combine that information. In other words, task and context effects on the information acquisition processes will be distinguished from their effects on the evaluation/action processes. While the feedback/learning processes are assumed to interact with information acquisition and evaluation, they will not be as stressed in the literature review.

Finally, the review will focus primarily on those studies that have shown task and context effects in situations of explicit risk. There are a number of reasons for this focus. First, the most general definitions of a decision problem include: (1) the courses of action or alternatives among which one must choose, (2) the possible outcomes and values attached to them, conditional on the actions, and (3) the contingencies or conditional probabilities that relate outcomes to action (G. Huber, 1980; Tversky and Kahneman, 1981). The evaluation and/or choice among a set of gambles captures all three of the basic types of information that comprise most decision problems. Second, the study of judgments and choices among gambles has been one of the most active areas of decision research (cf. Slovic, Fischhoff & Lichtenstein, 1977;

Einhorn & Hogarth, 1981). Third, understanding how individuals make decisions under risk has direct relevance for improving decisions in business (Libby & Fishburn, 1977) and public policy (Slovic, 1978). While the emphasis will be on studies of risky decision making, some studies of task and context effects under certainty will also be reviewed. The reason is that a few important task variables have only been studied in situations without explicit risk.

Task Effects

The first set of variables to be investigated are associated with the general structural characteristics of a decision problem. These variables affect task complexity or the amount of information to be processed by the decision maker in a given unit of time. Next, response mode effects are examined. Finally, display and agenda effects are briefly considered.

Task Complexity

A number of models of decision making have been proposed, such as the additive utility model, the expected utility model, the additive difference model, the conjunctive/disjunctive models, and the elimination-by-aspects model (see Svenson, 1979, for a review). The various models differ in two important ways: whether the decision process is assumed to be compensatory or noncompensatory (e.g., additive vs. conjunctive) and whether the processing of information is assumed to be organized around alternatives or attributes (e.g., additive vs. additive difference models).

A major determinant of which strategy will be used in a task concerns task complexity. The argument is that increases in task complexity will result in the increased use of strategies such as elimination-by-aspects since they reduce information processing demands. Note, that argument is consistent with a cost/benefit theory of task effects. Three problem characteristics

that are likely to impact on task complexity are: The number of alternatives in the choice set, the number of dimensions of information used to define an alternative, and the amount of time a person is given to make a decision.

Number of alternatives. A series of recent experiments involving both risky and nonrisky choice (Payne, 1976; Payne & Braunstein, 1978; Olshavsky, 1979) indicates that choice strategies are sensitive to the number of alternatives. For example, when faced with two-alternatives, subjects will employ compensatory types of decision strategies (as specified, for example, by information integration theory; see Anderson and Shanteau, 1970). However, when faced with more complex (multi-alternative) decision tasks, subjects appear to use choice strategies such as elimination-by-aspects (Tversky, 1972) or the conjunctive rule (Einhorn, 1970).

In terms of individual differences, this effect held for 17 of the 18 subjects in Payne (1976) and for 14 of 25 subjects in Payne and Braunstein (1978). Both studies, however, found large individual differences in the use of alternative-based vs. attribute-based processing.

There is also some evidence (e.g. Payne & Braunstein, 1978) that information acquisition becomes more attribute based as the number of alternatives increases. This effect of increasing the number of alternatives, however, does not appear to be as strong as the shift from compensatory to noncompensatory rules.

Number of outcomes (dimensions). Various studies have investigated the effects of number of dimensions of alternatives on decisions (e.g., Hayes, 1964; Hendrick, Mills, & Kiesler, 1968; Einhorn, 1971; Jacoby, Speller, & Kohn, 1974). In general, these studies show that increasing the amount of information about alternatives (1) increases the variability of responses, (2) decreases the quality of choices and (3) increases one's confidence in

judgment (Slovic & Lichtenstein, 1971). The first two effects may result from mechanisms of selective information acquisition. For example, the enlarged set of information may only be attended to on a selective (perhaps probabilistic) basis. Payne (1976), on the other hand, found no evidence that increases in the number of dimensions affected the underlying decision strategies. Olshavsky (1979) also found that increases in number of attributes did not change the choice rule used, but did increase the selective processing of the attributes.

The studies cited above involved nonrisky decision problems. For risky situations, there has been speculation that a small increase in the complexity of gambles, e.g., from gambles of the form (a, p) to gambles of the form (a, p, b) would also affect choice behavior (Lindman & Lyons, 1978). Kahneman and Tversky (1979) suggest that very complex gambles (multiple outcomes and probabilities) will be simplified through some sort of editing process. However, as they note, "the manner in which complex options, e.g., compound prospects, are reduced to simpler ones is yet to be investigated [p. 288]." One possibility suggested by Payne (1980) is that a decision maker might respond to complex gambles by treating all outcomes below and above a certain target or reference point as similar. A decision maker might then combine the probabilities associated with outcomes below the target into a composite probability of failure to meet the target, and similarly for above target outcomes. Some support for this possibility has been obtained by Payne (Note 2), but more research is needed.

Time pressure. Wright (1974) suggested that the complexity of a decision task could be varied by changing the time available to make a decision. He further suggested that a decision maker under time pressure would try to simplify the task by placing greater weight on negative information about

alternatives. Support for this hypothesis has been obtained (Wright, 1974; Wright & Weitz, 1977). More recently, Ben Zur and Breznitz (1981) have examined the effect of time pressure on choice among pairs of gambles. Subjects made less risky choices under high time pressure. Further, measures of information search showed that subjects tended to spend more time observing negative information (amount to lose and probability of losing) under conditions of high time pressure.

Wright and Weitz (1977) also demonstrated a related effect of time horizon on decision strategies. When the outcomes of a choice were to be experienced in the near future, subjects were more risk averse than when the outcomes were to be experienced at a more distant point in time. (The importance of the time horizon on decision making has recently been emphasized by Hogarth, 1981).

In summary, the hypothesis that increases in task complexity will result in changes in evaluation/choice processes seems to be strongly supported when considering the number of alternatives. There is less support for the hypothesis when changes in the number of dimensions is considered. The results of studies investigating time pressures also suggest a change in the salience of information under high time pressures. Unfortunately, the effect of time pressures on changes in evaluation strategies can not yet be determined. However, the overall pattern of results for this class of task variables strongly supports the cost/benefit principle of strategy selection.

Response Mode

Many of the most striking examples of changes in decision behavior due to variations in a task characteristic have involved response mode effects. Decision research has used two general response modes. The first, called a

judgment task, involves the successive presentation of single alternatives and asks the subject to assign to each alternative a value reflecting its psychological worth. Sometimes the value is in terms of a rating scale, e.g., 1-10, and sometimes the value might be an amount of money reflecting how much the subject would pay for the alternative. The other response mode, a choice, involves the presentation of two or more alternatives and asking the subject to select which alternative is most preferred. As a general principle, one would expect that the relative worths of alternatives would not change as a function of whether a judgment or choice was called for. If, for example, a person chose one gamble over another in a choice task, that person would be willing to pay more for the preferred gamble. This expectation has not always been upheld.

Bids (judgments) versus choices. In a series of experiments, Lichtenstein and Slovic (1971) and Lindman (1971) found that subjects would often indicate preference for one gamble over a second gamble when a choice procedure was used, but would pay more to play the second gamble when bidding procedure was used. Choices tended to be of the gamble in the pair with the higher probability of winning, but lower amount to be won. The higher bids were made for the gambles with the larger amounts to win, but smaller probability of winning. The results from these early experiments have been replicated in a Las Vegas casino setting (Lichtenstein & Slovic, 1973) and by economists seeking to discredit the earlier results (Grether & Plott, 1979). In particular, preference reversals were not reduced as a function of higher incentives. Grether and Plott argue that the failure to find an effect on incentives is evidence against a cost/benefit explanation of this task effect. Finally, Lichtenstein and Slovic (1973), report that the reversal effect was widespread across subjects.

The explanation offered by Lichtenstein and Slovic (1971; 1973) for the reversal in preference is that variations in response mode cause a fundamental change in the way people process information about gambles. In the choice mode, it is suggested that the processing is primarily dimensional (Tversky, 1969). That is, each dimension of one gamble might be compared with the same dimension of the other gamble. Furthermore, it is suggested that for many subjects the most important dimensions in such a comparison are the probabilities of winning and losing. In contrast, the bidding response (and the successive presentation format) is seen as leading to an "anchoring and adjustment" process. Such a strategy involves the use of one item of information about an alternative as an anchor or starting point for a judgment and then to adjust that anchor to take into account additional information. This represents an alternative-based evaluation procedure. The amount to win often serves as the anchor for a gamble that is basically attractive (Lopes & Ekberg, 1980). Because the adjustment to an anchor is usually insufficient (Slovic, Note 3), the gamble with the higher amount to win would be assigned a larger bid. This explanation of the preference reversal phenomenon involves a task influence on the salience of information, probabilities versus amounts, and also a change in the strategy for processing information, dimensional versus alternatives.

While the preference reversal phenomenon has been the most studied response mode effect, other studies have also examined the judgment versus choice distinction. Rosen and Rosenkoetter (1976), for example, compared a choice response with a judgment task involving a 100-point scale. They also used a strength-of-preference response, but the data from that task were similar to the choice task. The results support the hypothesis that a choice

task leads to more dimensional processing than a judgment task. Another major finding of Rosen and Rosenkoetter was that the effect of response mode on processing strategy is greatly affected by the degree to which the attributes defining a stimulus are interdependent. There was more alternative-based processing with stimuli such as gambles.

The research reviewed so far supports the conclusion by Einhorn and Hogarth (1981) that the kinds of evaluation processes associated with judgment are often related to choice behavior, but that judgment and choice responses are not equivalent tasks. However, the nature of this task difference needs further explication.

One component of judgment versus choice may be related to a distinction developed by Tversky (1977) between similarity and dissimilarity judgments. Tversky (1977) defines the similarity between objects a and b, in terms of feature sets denoted by A and B, respectively, in a similarity measure S(a, b) given by the following equation:

$$[1] \qquad S(a, b) = \theta f(A \cap B) - \alpha f(A - B) - \beta f(B - A)$$

where $(A \cap B)$ represents features that a and b have in common, and $(A - B)$ and $(B - A)$ represent features that are distinctive to a and b, respectively. θ, α, and β are parameters that impact on the salience, f, of the the various feature sets. Tversky argues that with judgments of similarity the focus is on the set $(A \cap B)$. On the other hand, with judgments of dissimilarity the focus is said to be on the distinctive features, $(A - B)$ and $(B - A)$. Choice would seem to be more related to a dissimilarity response. That is, what determines a choice between a and b is the distinctive features of a and b, not the features held in common. In fact, some models of risky choice, e.g., prospect theory (Kahneman and Tversky, 1979) suggest that probability-outcome

combinations held in common by two prospects will be edited out of the decision problem. However, note that with the typical rating or bidding judgment, all the features of an alternative are likely to be considered. This explanation of judgment versus choice task differences emphasizes the impact of task demands on the salience of information used in decision making. Furthermore, it suggests a close connection between an important task variable, response mode, and an often studied context effect, similarity among alternatives.

Another possible component of the judgment versus choice difference has recently been suggested by Slovic, Fischhoff and Lichtenstein (in press). They argue that choice often includes a justification process (see also Tversky, 1972). That is, part of the deliberations prior to choice are said to consist of "finding a concise, coherent set of reasons that justify the selection of one option over the others." This justification process is not seen as a major part of judgmental response. Consequently, the inconsistencies between judgments and choices are said to be caused by the justification process. A "justification" explanation is difficult to fit into either a cost/benefit or a perceptual type of theoretical framework. A rule-based or production system framework, however, might be used.

Finally, Hogarth (1981) has discussed how the differences between judgment and choice may be mediated by the degree to which the decision environment is static or dynamic. He appears to suggest, for example, that the degree of commitment required in a dynamic decision situation will impact on the degree to which behavior is more or less judgmental in nature. The more a commitment is required, the more choice-like will be the response.

<u>Other response effects</u>. Coombs, Donnell, and Kirk (1978) found that "substantial and significantly different levels of inconsistency of choice"

were obtained under instructions to pick one of three gambles as compared to instruction to reject one of three gambles. Although the final preference orderings were similar, the reject response mode yielded more consistent preference orders. Explanations offered for this effect included the possibility that the different response modes changed the salience of the various components of a gamble.

Finally, in two recent studies that have serious implications for normative decision analysis, Hershey, Kunreuther, and Schoemaker (in press) and Wehrung, MacCrimmon, and Brothers (Note 4) have shown that utility measures (risk attitudes) differ depending on whether a certainty equivalence, probability equivalence, or gain equivalence method is used to indicate an indifference point between a risky option and a sure thing option. Again, it has been suggested that the differences in equivalence methods results from the use of different information processing strategies. The basis for these response mode differences, however, is not yet understood.

Information Display

A third set of task variables concern how information is displayed to the decision maker. Tversky (1969), for example, has suggested that the use of an additive versus additive difference rule in comparing two alternatives would be affected by how the alternatives were displayed. The additive rule was seen as more likely under a sequential presentation of alternatives while the additive difference rule was viewed as more likely under a simultaneous presentation of alternatives. Unfortunately, Tversky presented no data in support of his suggestion.

A study by Aschenbrenner convincingly shows the effects of presentation mode on preferences among gambles. He asked subjects to indicate preferences

for gambles presented in the form (x, p; y, 1-p), where one wins amount x with probability p or loses amount y with probability 1-p, and also to indicate preferences for gambles of the form (y, p, x + y), where one pays the stake y, in advance, in order to play the game involving a p chance of winning x + y or winning nothing with probability 1-p. Notice that for given values of x, y, and p, both forms of gamble are equivalent in terms of final outcomes and probabilities. Nonetheless, Aschenbrenner reports that the preference orders obtained under the two presentation modes showed "hardly any relation for the same gambles."

Aschenbrenner interprets his results as showing that subjects use the dimensions of gambles "as they are presented to them rather than transform the gambles into final outcomes or calculate subjective moments." Aschenbrenner's conclusion is similar to the "concreteness" principle proposed by Slovic (Note 3). He suggested that decision makers will tend to use only that information that is explicitly displayed in the stimulus object and will use it only in the form in which it is displayed. The argument is that in order to reduce the cognitive strain of integrating information, any information that has to be stored in memory, inferred from the display, or transformed will be discounted or ignored. Note that this explanation of a display effect on decision behavior involves the same information processing considerations used in explaining the effects of task complexity on choice and fits within the more general cost/benefit framework. Another possible explanation is a framing effect due to the failure by people to integrete riskless (e.g. stakes) and risky prospects suggested by Kahneman and Tversky (1979). Additional data is needed to test these two explanations.

Information processing considerations and the effects of alternative information displays were stressed by Russo (1977) in a study of the use of

unit price information by supermarket shoppers. He found that the use of unit price information increased when the information was brought together for shoppers in the form of organized lists. As noted by Einhorn and Hogarth (1981), an important aspect of this study is that it represents a form of decision aiding based on the information acquisition stage as opposed to more traditional aids based on the evaluation stage of decision behavior.

Another important issue concerned with the display of information is the problem of partially described options. That is, what happens when a subject is asked to evaluate alternatives on a set of dimensions, but information about the values of the alternatives on all dimensions is incomplete? There are a number of ways in which decision makers may respond to such a situation. For example, it may be that the values of any missing information will be inferred by the subject. The inferred value might be the "average" value or might depend on the values of the alternative on other dimensions. A related idea is that subjects recognize the uncertainty of an inference and consequently discount partially described alternatives as a form of uncertainty avoidance (Yates, Jagacinski, & Faber, 1978). Other possible responses include the idea that subjects will weight common dimensions more heavily than unique dimensions due to cognitive ease of comparison (Slovic & MacPhillamy, 1974), or the somewhat contrary idea that dimensions that are occasionally unique (i.e., have missing values) will draw more attention (Yates, et. al., 1978).

Studies investigating decision making among partially described alternatives are limited in number and restricted to stimuli other than gambles. Nonetheless, the results suggest that several types of responses occur. In particular, the cognitive ease, discounting, and unique attention hypotheses have all received support (Slovic & MacPhillamy, 1974; Yates, et.

al., 1978.

In discussing these results, Yates, et. al. raise two important issues. First, they note that a given task or context effect may be a function of several response tendencies. In other words, both error/effort and perceptual processes may be evoked in solving a given decision task. There has been almost no research that has attempted to measure the relative magnitudes of response tendencies. However, it is obvious that as we move away from the simplest laboratory situations, behavior will be the result of conflicting response tendencies. Second, Yates, et. al. point out that attention-effecting events in the real world are likely to be numerous and powerful. Consequently, if one wants to accurately represent how people make real judgments, naturally occuring attention-effecting events, such as incomplete displays, should not be dismissed as just experimental nuisance factors.

Finally, potentially important display effects have been found in several other studies. Bettman and Kakkar (1977) found that information acquisition will proceed in a fashion that is consistent with the display format. For example, with a display that encouraged alternative-based processing, e.g., the typical supermarket displays, more alternative-based processing was observed. The findings by Bettman and Kakkar, while perhaps not suprising, are important. They suggest, along with Russo (1977), how decision behavior can be changed and improved by simple information display changes. O. Huber (1980) demonstrates that whether information is presented in a numerical or verbal form can also impact on decision behavior. There are more direct within attribute comparisons with numerical information and less use of comparison against some criterion (see also Slovic Note 3). Fischhoff, Slovic and Lichtenstein (1978) have shown how the apparent completeness of display

can blind a decision maker to the possibility of information that is missing from a problem description. Phelps and Shanteau (1978) show that the number of cues used to make a judgment depends upon the degree to which a stimulus display is decomposed for the decision maker.

The fact that information display can effect decision behavior is clearly established. What is not known is the relative magnitudes of all the effects and how they may interact when placed in conflict. We also do not know the extent to which the various display effects represent effort/error tradeoffs or the impact of perceptual principles. Such information is clearly needed. Information on display effects not only provides insight into basic decision processes, but also impacts on the design of decision aids such as computer-based decision support systems (cf. Keen & Scott-Morton, 1978).

Agenda Effects

Recently, Tversky and Sattath (1979) have explored the effects on choice of placing constraints on the order in which elements of a choice set are considered by an individual. An example given by Tversky and Sattath concerns a Psychology faculty appointment decision. There are four candidates, x, y, v, w. Two of the candidates would be senior appointments, x and y, and two would be junior appointments v and w. Two of the candidates might be in the area of developmental psychology, x and v, and two in the area of social psychology y and w. Given that one of the four candidates is to be selected, how might the probability of choice be affected by the requirement to first choose between (x, y) and (v, w) and then to choose from the selected pair vs. choosing between (x, v) and (y, w) first?

Tversky and Sattath demonstrate agenda effects on individual choices among sets of gambles consisting of two risky prospects x and y with similar probabilities and outcomes and one sure thing option, z. Gamble x, for

example, might yield $40 with probability .75, otherwise nothing. Gamble y might yield $50 with probability .70, otherwise nothing. And, option z would be $25 for sure. Note that y is superior to x in terms of expected value. Two agenda constraints were considered. Under one agenda, the choice was first between the pair [x, y] and z. Under the second agenda, the choice was first between the pair [x, z] and y. In both cases, if the pair was selected, the subject later had to chose the preferred element of the pair.

The hypothesis was that the first agenda reflected a natural hierarchical choice process involving a choice between risky options [x, y] and a nonrisky option. If the decision maker decides to take a risk, the superior (EV) option y is likely to be selected. However, note that the agenda [x, z] and y conflicts with such a hierarchical choice process. The prediction was that forcing the decision maker to choose under the latter agenda would increase the probability that x would be selected. The results supported that prediction.

It is not clear from Tversky and Sattath's data the extent to which the evaluation rules may have been changed under the two agendas. The implicit asumption would seem to be that a hierarchical elimination process was used under both agendas, in which case the agenda effect would have to be interpreted as involving a change in the features (i.e., aspects) considered in the elimination process.

Finally, note that the agenda effects shown by Tversky and Sattath involved an assumed interaction between task structure (i.e., the agenda) and the similarity structure among the alternatives in the choice set. This again suggests the interrelatedness of task and context variables on decision behavior. Plott and Levine (1978) discuss how agendas influence committee decisions.

Context Effects

Context variables are those associated with the values of the stimuli in the decision set under consideration. Perhaps the most studied context variable is the similarity of objects in a set. Other context variables such as the overall attractiveness of the choice set and range of outcomes have also been shown to affect decision behavior.

Similarity of Alternatives

The need to consider the similarity among alternatives has long been recognized. The classic examples of the influence of similarity structures on choice involve violations of the constant ratio model (CRM) or Luce's choice model. The model developed by Luce (1959) states that the probability of choosing an alternative X from some set of alternatives A is given by the following equation:

[2] $$P(X; A) = \frac{U(X)}{\sum_{y=1} U(Y)}$$

where U(X) reflects the utility of alternative X and U(Y) reflects the utility of each of the elements of set A. Note that the ratio P(X, A)/P(Y, A) would be a constant. This means that the relative choice probabilities of two alternatives X and Y would depend on the utilities of X and Y but not on the values of other alternatives in the offered set A.

Evidence that the values of the other alternatives in A do make a difference on the ratio P(X, A)/P(Y, A) has been provided by a number of researchers (Debreu, 1960; Restle, 1961; Rumelhart and Greeno, 1971; Tversky, 1972). It appears in the words of Tversky (1972), "That the addition of an alternative to an offered set hurts alternatives that are similar to the added set more than those that are dissimilar to it [p. 283]." It should also be

noted that the effect of similarity on choice probabilities violates not only the CRM but a more general principle of choice referred to as independence from irrelevant alternatives. (See Luce, 1977 for a reivew of the CRM, other probabilistic choice models, and relevant experimental studies.)

In order to account for the effect of similarity of choice, Tversky (1972) developed a theory of choice based on a hierarchical elimination process. According to this model, called Elimination-by-Aspects (EBA), each alternative in an offered set (A) can be viewed as a collection of measurable aspects. A decision is made by first selecting an aspect from those included in the available alternatives with a probability that is proportional to its measure or importance. All alternatives that do not possess that aspect are then eliminated. That process is continued until only a single alternative remains. Tversky (1972) shows how an EBA type decision rule would account for the observed violations of the CRM due to similarity. As noted earlier, Payne (1976) provides evidence that the use of an EBA process is particularly likely when the choice task becomes complex.

While an EBA type decision rule handles a number of important context effects due to similarity, the conclusion associated with that model that "if x has more in common with y than with z, for example, then the addition of x to the set (z, y) tends to hurt the similar alternative y more than the less similar one z [Tversky & Sattath, 1979, p. 548]," is not always true. Huber, Payne, and Puto (Note 4) have shown that this similarity hypothesis is violated by the addition of an asymmetrically dominated alternative. An alternative is "asymmetric" if it is dominated by at least one alternative in the set but is not dominated by at least one other. The addition of an asymmetrically dominated alternative increased the choice of the alternative that dominates. Since the new alternative is typically closest to the item

that dominates it, that is more similar, this implies that the new alternative "helps" not "hurts" the items closest. The explanations offered by Huber et. al. for this effect include both error/effort concepts and perceptual principles. The causes of the effect, however, are not yet fully understood.

Similarity has been suggested as affecting the ease of comparison between alternatives (Shugan, 1980; Tversky & Sattath, 1979). Of particular relevance to this review is the idea offered by Shugan that the cost of thinking associated with the use of various decision strategies is based, in part, on the perceptual similarity between alternatives. Specifically, it is said that the cost of thinking is inversely related to perceptual similarity. If the Shugan hypothesis is true, it suggests that the use of compensatory versus noncompensatory decision strategies may vary as a function of the perceived similarity among alternatives. The more similar the alternatives the more a compensatory rule will be used. This idea represents an integration of perceptual and cost/benefit principles.

Similarity structures among alternatives is clearly an important context variable since choice probabilities are strongly influenced by it. The cognitive effort associated with making a choice may also be a function of similarity. And, as mentioned earlier in this paper, perceptual similarity may be related to the influence of such task variables as response modes and agenda effects. To paraphase a statement by Tversky and Sattath (1979), any theory of decision making that allows for contingent processing will have to incorporate the similarity structure among alternatives as an essential component of the theory.

Quality of Option Set

The quality or nature of the options available in the choice set has been

suggested as a variable affecting the information processing involved in risky decisions. Williams (1966), for example, suggested that a distinction be made between "pure-risk" and "speculative-risk" situations. In both there is doubt or uncertainty concerning the outcomes, but in the pure-risk situation there is no chance of gain. The person faces only a loss or the status quo. In the speculative-risk situation there is a chance of gain. On the basis of a small pilot study, Williams concluded that, "people react differently to pure risks and speculative risks [p. 585]."

The idea that choice processes would differ depending on whether the outcomes of the gambles were primarily losses or primarily gains has been extensively investigated by Payne, Laughhunn, and Crum, (1980; 1981). In a series of experiments, involving both students and business managers as subjects, the relationship of a pair of gambles relative to an assumed reference point, target, or aspiration level, was varied by adding or substracting a constant amount from all outcomes. It was shown that such a translation of outcomes could result in a reversal of preference within the pair. The key determinant of the effect of the translation was whether the size of the translation was sufficient to result in one gamble having outcome values either all above or all below a reference point, while the other gamble had outcome values that were both above and below the reference point. A model of the effects of aspiration levels on risky choice is presented in Payne et. al. (1980). The heart of the model is the idea that the preference function used to choose among gambles is contingent on whether the choice problem is one involving mainly positive outcomes, a mixture of positive and negative outcomes, or mainly negative outcomes.

A related theory has been proposed by Coombs and Avrunin (1977). They view choice as a form of conflict resolution. Three types of conflict

situations are identified: approach-avoidance, approach-approach, and avoidance-avoidance. Although the Payne, Laughhunn, & Crum model identifies five such conflict situations, both models emphasize the importance of the nature of the decision conflict and how behavior will be contingent upon the perceived conflict.

Additional empirical support for the role of choice set quality is provided by experiments reported in Payne (1975), Payne and Braunstein (1971), and Ranyard (1976). Those studies suggest that individuals will often make an initial judgment about whether they are faced with an attractive set of gambles (where the probability of winning exceeds the probability of losing) or an unattractive set (where the probability of losing exceeds the probability of winning) before deciding on the choice rule to be use. Payne and Braunstein (1971) suggest that such a contingent processing strategy may provide a mechanism for reducing the information that needs to be processed in making a choice.

The concepts of gains/losses, winning/losing, etc., imply the existence of a neutral reference point that can be used to code outcomes. Such a coding process is a central component of prospect theory (Kahneman & Tversky, 1979; Tversky and Kahneman, 1981). The need for a reference point concept in the analysis of risky choice behavior is supported by showing that the preference ordering between gambles involving negative amounts of money is often the reverse (reflection) of the preferences between gambles involving positive amounts of money (see Kahneman & Tversky, 1979).

Tversky and Kahneman (1981) have also shown how simple changes in the wording of a decision problem can reverse preferences due to the differences in response to gains and losses. For example, in one problem you are asked to imagine that the U.S. is faced with the outbreak of a certain Asian disease

that is expected to kill 600 people. You are asked to indicate your preference between two alternative programs to combat the disease. In one wording of this problem, the first alternative is said to result in 200 people being saved. The second alternative is said to save 600 people with probability 1/3 and no people with probability 2/3. Most people prefer the first alternative. In a rewording of the problem the first alternative is said to result in the death of 400 people. The second alternative gives a 1/3 probability that none will die and 2/3 chance that 600 people will die. Most people in this case prefer the second alternative. Why the reversal in preference? Tversky and Kahneman argue that the first wording causes people to code the possible outcomes as gains and the second wording causes the outcomes to be coded as losses. Furthermore, because people often are risk averse for gains and risk seeking for losses, you observe the reversal in choice between two problems that are <u>effectively identical</u>. These results represent strong support for the Kahneman and Tversky perceptual approach to handling context effects. The effects described above appear very strong. In addition, it is hard to see how a simple wording change could change either cognitive costs or the desire for accuracy.

Similarity and the quality of the option set as perceived by the decision maker are the two most extensively investigated context effects. Two other context effects that deserve mention are range of outcomes and whether a risky decision is formulated as a gambling or insurance problem.

Fryback, Goodman, and Edwards (1973) found that variance preferences among gambles were more related to the range of variance offered to the subjects than to absolute levels of variance. They concluded that the desirability of a gamble is not solely dependent upon the characteristics of that gamble, but also depends upon the context defined by the set of gambles

offered to the subjects. This effect was found in a situation involv the potential to gain or lose substantial amounts of money. As noted by Fryback, et. al. the observed range effect suggests that perceptual concepts such as adaptation, contrast, and assimilation (cf. Helson, 1973) "can no longer be ignored by a theory that attempts to describe human decison making." More evidence of range effects is provided in Krzysztofowicz and Duckstein (1980).

A good example of how a choice and insurance formulation of the same decision under risk can lead to different behavior is provided by Slovic, Fischhoff and Lichtenstein (in press). In one choice problem, you are asked to decide between a sure loss of $50 versus a gamble with a .25 chance of losing $200 and a .75 chance of losing nothing. In the related insurance problem, you are asked to decide whether to pay an insurance premium of $50 in order to protect aginst .25 chance of a $200 loss. The majority of subjects choose the risky prospect in the first problem and a majority of subjects decided to pay the premium in the second problem. Several explanations of this type of context effect have been offered (e.g., Hershey & Schoemaker, 1980; Kahneman & Tversky, 1979; Kunreuther, in press; Slovic, Fischhoff, & Lichtenstein, in press).

One particularly interesting explanation is that an insurance formulation of a risky choice problem causes the decision maker to introduce a regret attribute into the problem, as well as the given monetary loss and probability attributes (Kunreuther, In press). Keeney (Note 6) has advanced a similar idea of additional attributes to account for the risk seeking behavior in the domain of losses that has been documented by many researchers. Additional evidence that subjects will use cues in judgment that are not explicitly provided in the task environment is provided by Shanteau and Nagy (1979).

Schoemaker (1980) has noted that the idea of an additional attribute as

an explanation of a context effect raises the more general problem of defining the psychologically relevent outcomes space as perceived by a decision maker. This outcome space, also called the problem space (Newell & Simon, 1972), will be related to the task environment as defined by the researcher, but it must be distinguished from the task environment. Problem spaces will represent the interaction between the task environment and the individual's cognitive system, including schemes or scripts (knowledge structures) held by the individuals for dealing with problems such as the purchase of insurance. Such schemes or scripts may cause decision makers to go beyond the explicitly given information in decision problems. See Abelson (1981) for a recent and general discussion of the script concept in psychology.

THE SEARCH FOR GENERAL PRINCIPLES

The present review strongly supports the conclusion that decision making is a highly contingent form of information processing. The sensitivity of decision behavior to seemingly minor changes in task and context is one of the major results of years of decision research. It will be valuable for researchers to continue to identify task and context effects. However, the primary focus of decision research should now be the search for some general principles from which contingent processing would follow.

The present paper has identified three possible theoretical frameworks: (1) cost/benefit, (2) perceptual, and (3) production systems. The research review indicated that both the cost/benefit framework and the perceptual framework have strong support. For example, the task effects due to number of alternatives fit the cost/benefit framework very nicely. It is not clear how the perceptual framework would handle that phenomenon. On the other hand, the context effects due to slight wording changes, e.g., gains vs. losses, seem

consistent with the perceptual framework. It is hard in that case to see how such wording changes increase either cognitive effort or the desire for accuracy. Both theoretical frameworks also have some unresolved problems or issues that need to be discussed. For instance, the cost/benefit framework evokes the question: How can we measure the differing costs and benefits associated with various decision strategies? Both the frameworks evoke the question, to what extent is strategy selection an aware or unaware process? Finally, the question concerning how the perceptual/decision response tendencies have developed needs to be further explored. The third framework, adaptive production systems, has less direct empirical support than either of the two. At a general level however, production systems may provide the vehicle for integrating concepts drawn from both the cost/benefit and perceptual frameworks.

The next section of this paper further explores some of the issues associated with the theoretical frameworks. The question of how the different frameworks might be integrated is briefly discussed at the end.

Measurement of error and effort. The use of an effort/error or cost/benefit model for strategy selection raises questions concerning how error and effort are to be measured. Recent papers by Johnson (Note 7), Shugan (1980), and Thorngate (1980) have proposed some answers to those questions.

To define a choice error one must have, of course, some method for identifying the "best" alternative in a set. The standard measure of best has been either the alternative that would have been selected through an expected value rule or additive utility rule (Thorngate, 1980). Error could then be measured as the probability of failure to select the "best" alternative. One could extend that idea to include in the error measure both the probability of an error and the size of the error, i.e., the difference in utility between

the selected alternative and the "best" alternative. Such a procedure for defining a decision error is reasonable. However, it is important to recognize how conditional our definition of error is on the rule we use to measure the best alternative and on other, often implicit, assumptions such as the appropriate time horizon (Einhorn & Hogarth, 1981).

The problem of measuring effort is likely to be even more difficult than the measure of error. Shugan (1980) has proposed that the basic unit of thought in decision making is the comparison between two alternatives on a single attribute. The cost of thinking then is simply the number of comparisons that are made. The number of comparisons is seen as a function of (1) the desired probability of making a correct choice, denoted α, and (2) the difficulty of making a choice. That last factor is seen as a function of the "true" difference in mean utility between the two alternatives and the variability in the attribute differences between the two alternatives. Attribute differences are assumed to be sampled until the decision maker feels confident ($P > \alpha$) that one alternative or the other is better.

Shugan's measure of the cost of thinking is useful in that it clearly identifies two task characteristics that will impact on decision behavior: the quality differences between alternatives, and a measure of similarity. The measure has a number of limitations, however. First, the measure assumes a fixed cost per attribute comparison which is questionable. Even more important, the assumption that an additive difference type process (Tversky, 1969) is the basic decision model seems restrictive. As a result, when estimating the costs of thinking associated with decision strategies such as a conjunctive rule or a maximum rule, Shugan is forced to transform the initial alternative by attribute value matrix into a special matrix of values which can then be used to approximate other strategies by the additive difference

model. While such a transformation process may occur, it does not seem likely. Furthermore, if such a transformation does occur, it would certainly involve cognitive effort and therefore should be included in any measure of thinking costs.

Johnson (Note 7) has also suggested a method for estimating the effort required to use various decision rules. The basis of his approach is the identification of a small set of elementary mental operations that when combined in certain ways correspond to strategies such as the additive utility rule. Included might be multiplication, addition, subtraction, and comparison operations. The idea of identifying a set of elementary operations which then are combined into problem solving strategies has been advanced by Newell and Simon (1972). Bettman (1979) has proposed a related idea in his concept of constructive decision processes.

The effort associated with various decision rules is estimated by counting the number of elementary mental operations a rule would require in a given decision situation. It is assumed that the strategies are operated efficiently. That is, only the minimum number of operations required will be executed. It is further assumed that addition (subtraction), multiplication, and comparison are all equally effortful operations. Finally, Johnson does not impose any cost of such "bookkeeping" operations as keeping track of what alternatives have been considered. He considers that they are automated (Shiffrin & Schneider, 1977).

Some of the assumptions made by Johnson are probably wrong. In particular, memory based operations need to be accounted for. Nonetheless, the general approach suggested is exciting. While one might not have too much faith in the exact effort value for a given strategy, the measure is useful in suggesting how relative effort values may change as a function of task

variables. For example, Johnson shows that the effect of increasing the number of alternatives available is a relatively slight increase in the effort associated with an EBA strategy as compared to the much more rapid increase in effort using an additive difference strategy. Further, he shows that with six attributes, the additive difference rule is relatively much more effortful than EBA with six alternatives but actually may be less effortful with just two alternatives. It is suggested that this may account for the types of phased decision strategies observed by Payne (1976) and Svenson (Note 8).

Awareness of contingent processing. As noted earlier, the assumed degree of awareness of task effects represents a major difference between the cost/benefit and perceptual frameworks. Unfortunately, the determination of whether strategy selection, or other forms of contingent processing, is an aware process or not is likely to be difficult. Some of the clearest evidence that people are aware of contingent processing is provided by verbal protocol data. For example, Payne (1976) reports the following protocol excerpt:

> "Well, with these many apartments to choose from; I'm not going to work through all the characteristics. Start eliminating them as soon as possible." [p. 376]

Verbal reports such as the above, seem to imply at least some level of awareness of the relationship between task variables and strategy selection. On the other hand, consider the evidence that organisms such as birds also often appear to be highly adaptive to task demands (cf. Staddon & Motheral, 1978). Are such organisms consciously considering cost/benefit efficiencies? Staddon and Motheral suggest not. They argue that such organisms simply rule off programs molded by natural selection to operate adequately in normal environments. As evidence, they cite that fact that slight changes in the

normal environment of an organism can result in rather major changes in the apparent optimality of behavior. A deliberate error/effort tradeoff process, in contrast, should probably result in a less abrupt decrease in performance. More data on the awareness question, and the related question of the pattern of performance decrements in decision making, needs to be collected.

Learning and development. The process by which decision strategies develop are learned is not well known. Nonetheless, it seems worthwhile to relate theories of contingent decision behavior to various learning and developmental assumptions.

Consider, for example, the production system framework. Anzai and Simon (1979) illustrate an adaptive production system that learns (creates productions) to avoid actions that have lead to bad results in the past. Specifically, if P1, P2, and P3 are successive positions along a problem solution path, and A1 and A2 are actions that take P1 into P2 and P2 into P3, respectively, then if P1 = P3, a production is created that will recognize the situation and will exclude the move A2. Note that such an adaptive production system stresses learning from individual experience. Additional examples of the use of adaptive production systems to model how cognitive strategies are learned can be found in Anderson (1981).

There are a number of issues associated with decision behavior and learning from experience (Brehmer, 1980; Einhorn, 1980; Einhorn & Hogarth, 1981). For example, in order to learn from experience one needs to know outcome information, the role of task factors in influencing outcomes, and some awareness of the rules being used to select actions that have led to outcomes (Einhorn & Hogarth, 1981). In a number of decision environments information about such factors is likely to be incomplete or lacking. In particular, as noted by Brehmer (1980), learning from experience in

probalistic environments is likely to be particularly poor. Furthermore, Einhorn and Hogarth (1981) also raise the possibility that a decision maker will choose not to learn. The conclusion seems to be that while adaptive learning is certainly possible, it is quite likely to be slow, and at times incorrect. In addition, Einhorn (1980) points out that learning from experience means that the heuristics people develop should be extremely context dependent.

Overall, the production system framework as it relates to learning assumptions implies that task contingent behavior will, once it is learned, persist for long periods of time even if the application of the response to situations leads to apparently dysfunctional behavior. It also suggests that individual differences in experiences are likely to be strongly correlated with the degree and kind of task context effects that are observed.

The role of learning within the cost/benefit and perceptual frameworks is less clear. As noted earlier, the perceptual (framing) framework could be viewed in terms of hardwired responses. That is an extreme position. Individual histories probably do influence the development of various editing operations. Although, it would be interesting to know the extent to which the development of editing operations could be characterized in terms of a universal set of stages. Nonetheless, the perceptual framework implies that individual differences in experiences will be less correlated with decision behavior than the production system framework would suggest.

One could argue that the cost/benefit framework does not involve any learning assumptions. The idea would be that each decision problem represents an independent evaluation of cost and benefits. That is unlikely. A more reasonable view is that people over time learn relationships between certain task variables and the expected costs and benefits associated with various

decision strategies. For example, one might learn that a decision problem involving a large number of alternatives is one where an elimination-by-aspects process will likely produce a satisfactory solution with relatively little effort. Consequently, one might develop the rule: If number of alternatives is greater than N, evoke an elimination process. A particular decision problem then might not involve a consideration of costs and benefits as much as it might involve a consideration of previously learned important task variables. Of course, this view of learning does require some ability to learn from experience. In addition, this view of learning and cost/benefit considerations suggests why context effects may occasionally be observed in situations that do not exceed human information processing ability. Finally, such a view of learning and the cost/benefit framework provides a link between that framework and the concept of production systems.

Towards an Integration of Theories

A number of issues related to the three alternative explanations of contingent decision behavior have been discussed. Further work on each theoretical framework is needed. It is becoming clear, however, that a complete explanation of contingent decision behavior will include concepts drawn from the cost/benefit, perceptual, and production system frameworks. Decision behavior likely consists of multiple systems that interact in various ways. That general idea is, of course, not original with me. For example, Broadbent (1977) provides a discussion of the old idea in psychology that human processing of information takes place on many levels that can operate relatively simultaneously, and in some sense independently. Each process is also seen as having the potential of altering the operation of another. The problem is to develop a theory to account for the coordination of the multiple systems in a given decision situation.

The script concept (cf. Abelson, 1981) may provide at least a partial way of unifying perceptual, motivational (cost/benefit), and learning explanations of task effects in decision making. Consider, for example the idea in Abelson (1981) that scripts may serve as performance structures or guides for behavior. When thought of in that fashion, scripts represent strategies for making decisions. Furthermore, Abelson argues that the use of a script in a particular situation is critically dependent on the satisfaction of an action rule attached to the script. An action rule is a small set of conditions, including incentive and effort, that when satisfied evoke the related script. The idea of action rules is used to explain how small or apparently irrelevant variations in the situational context often make large differences in behavior. Note that an action rule is similar to a production rule when the action part of the production is a call to a complex subroutine (script). Scripts are also seen as being learned in the course of an individual's ordinary experience. In addition, scripts apparently play a role in how people come to understand or represent their environment. This suggests that scripts may be an important part of decision framing, particularly for complex or familiar decision problems. At the moment, the concept of scripts is still incompetely articulated, but it does seem to offer a link between the theoretical frameworks of interest in this paper.

Hammond (Note 9), in a paper aimed at the ambitious task of unifying the field of decision research, offers an even more general approach. He strongly argues that elements of both intuitive (perceptual) and analytical (reasoning) thought are present in most decisions. As a first step toward understanding the coordination of intuitive and analytical thought, he has developed a list of task factors that induce intuition and analysis to various degrees. A number of those task factors are supported by the research reviewed in the

present papers, e.g., time pressures, number of alternatives. Other factors and their proposed relationships to behavior appear to contradict the research that has been reviewed. For example, Hammond suggests that the simultaneous display of information will lead to greater use of the linear model than will the sequential display of information. The work of Tversky, Russo, and others, on the other hand, suggests that simultaneous displays will lead to more dimensionally based strategies such as the elimination-by-aspects rule.

Perhaps even more important for dealing with the coordination of behavior issue is Hammond's suggestion that congitive activities may move along that intuitive-analytic continuum over time. For that reason he argues that decision researchers need to pay more attention to the temporal aspects of decision behavior. I agree and would argue that a concern with the temporal aspects of decision behavior is the main reason for adopting process tracing methods of research such as verbal protocols (cf. Payne, Braunstein & Carroll, 1978).

Hammond further suggests that decision behavior often involves a switching back and forth between analysis and intuition. The switching is motivated by the failure of one mode of thought to lead toward a problem solution. The idea of switching among modes of thought seems reasonable. However, the relationship between time and modes of thought may have even more order than Hammond suggests. Consider, for example, prospect theory (Kahneman & Tversky, 1979). As noted earlier,a key concept in prospect theory is that risky choice behavior consists of a two phase process. The first phase involves editing the given decision problem into a simpler representation in order to make the second phase of evaluation and choice of gambles easier for the decision maker. Included in the first phase are such editing operations as coding, cancellation, and segregation (Kahneman & Tversky, 1979; Tversky &

Kahneman, 1981). Editing operations would seem to correspond to the intuitive and perceptual mode of thought. Evaluation would be more an analytical mode of thought. Consequently, a combination of the Hammond and Kahneman and Tversky ideas suggests that a complex risky choice problem will involve a progression from intuitive to analytical cognition. This suggests that the types of errors observed and the influence of various task variables will vary systematically over the course of the risky problem solving episode. Of course, the possibility exists that the process of intuitive to analytical cognition could be short circuited at any time.

Finally, it is interesting to speculate on the developmental implications of the intuitive-analytic distinction. One might argue that development will progress from more intuitive modes of thought to more analytic. Another possibility is that developing into an expert may involve using more perceptual forms of processing (see Chase & Simon, 1973). Of course, at every developmental stage both forms of cognition will likely exist. Cooper (1980) provides a discussion of the related distinction between holistic and analytic ways of processing visual information and perceptual development.

Summary

We now know that the information processing in decision making is highly contingent upon the demands of the task. However, we are just beginning to understand the underlying psychological mechanisms that lead to contingent decision behavior. That understanding is likely to be advanced by adopting a time dependent (process) view of decision behavior. It appears that the response to a decision problem will involve a contingent mixture of decision processes, e.g., coding, cancellation, elimination-by-aspects, and compensatory trade offs.

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Training Analysis and Evaluation
Group
Naval Training Equipment Center
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Orlando, FL 32813

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Combat Control Systems
Naval Underwater Systems Center
Newport, RI 02840

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Operations Research Department
Naval Postgraduate School
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Mr. Warren Lewis
Human Engineering Branch
Code 8231
Naval Ocean Systems Center
San Diego, CA 92152

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Dr. A. L. Slafkosky
Scientific Advisor
Commandant of the Marine Corps
Code RD-1
Washington, D.C. 20380

Mr. Arnold Rubinstein
Naval Material Command
NAVMAT 0722 - Rm. 508
800 North Quincy Street
Arlington, VA 22217

Commander
Naval Air Systems Command
Human Factors Programs
NAVAIR 340F
Washington, D.C. 20361

CDR Robert Biersner
Naval Medical R&D Command
Code 44
Naval Medical Center
Bethesda, MD 20014

Dr. Arthur Bachrach
Behavioral Sciences Department
Naval Medical Research Institute
Bethesda, MD 20014

CDR Thomas Berghage
Naval Health Research Center
San Diego, CA 92152

Dr. George Moeller
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Submarine Medical Research Lab
Naval Submarine Base
Groton, CT 06340

Head
Aerospace Psychology Department
Code L5
Naval Aerospace Medical Research Lab
Pensacola, FL 32508

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San Diego, CA 92152

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Human Factors Engineering Division
Naval Air Development Center
Warminster, PA 18974

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Human Factors Engineering Division
Naval Air Development Center
Warminster, PA 18974

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Human Factors Branch
Code 3152
Naval Weapons Center
China Lake, CA 93555

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U.S. Army Research Institute
5001 Eisenhower Avenue
Alexandria, VA 22333

Director, Organizations and
Systems Research Laboratory
U.S. Army Research Institute
5001 Eisenhower Avenue
Alexandria, VA 22333

U.S. Air Force Office of Scientific
Research
Life Sciences Directorate, NL
Bolling Air Force Base
Washington, D.C. 20332

Chief, Systems Engineering Branch
Human Engineering Division
USAF AMRL/HES
Wright-Patterson AFB, OH 45433

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Dr. Earl Alluisi
Chief Scientist
AFHRL/CCN
Brooks AFB, TX 78235

Dr. Kenneth Gardner
Applied Psychology Unit
Admiralty Marine Technology
Establishment
Teddington, Middlesex TW11 OLN
ENGLAND

Director, Human Factors Wing
Defence & Civil Institute of
Environmental Medicine
Post Office Box 2000
Downsview, Ontario M3M 3B9
CANADA

Dr. A. D. Baddeley
Director, Applied Psychology Unit
Medical Research Council
15 Chaucer Road
Cambridge, CB2 2EF
ENGLAND

Defense Technical Information Center
Cameron Station, Bldg. 5
Alexandria, VA 22314 (12 cys)

Dr. Judith Daly
System Sciences Office
Defense Advanced Research Projects
Agency
1400 Wilson Blvd
Arlington, VA 22209

Dr. Robert R. Mackie
Human Factors Research, Inc.
5775 Dawson Avenue
Goleta, CA 93017

Dr. Gary McClelland
Institute of Behavioral Sciences
University of Colorado
Boulder, CO 80309

Dr. Jesse Orlansky
Institute for Defense Analyses
400 Army-Navy Drive
Arlington, VA 22202

Dr. T. B. Sheridan
Department of Mechanical Engineering
Massachusetts Institute of Technology
Cambridge, MA 02139

Dr. Paul Slovic
Decision Research
1201 Oak Street
Eugene, OR 97401

Dr. Harry Snyder
Department of Industrial Engineering
Virginia Polytechnic Institute and
State University
Blacksburg, VA 24061

Dr. Amos Tversky
Department of Psychology
Stanford University
Stanford, CA 94305

Dr. W. S. Vaughan
Oceanautics, Inc.
422 6th Street
Annapolis, MD 21403

Dr. Robert T. Hennessy
NAS - National Research Council
2101 Constitution Ave., N.W.
Washington, DC 20418

Dr. M. G. Samet
Perceptronics, Inc.
6271 Variel Avenue
Woodland Hills, CA 91364

Dr. Robert Williges
Human Factors Laboratory
Virginia Polytechnic Institute
and State University
130 Whittemore Hall
Blacksburg, VA 24061

Dr. Alphonse Chapanis
Department of Psychology
The Johns Hopkins University
Charles and 34th Streets
Baltimore, MD 21218

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Dr. Ward Edwards
Director, Social Science Research
Institute
University of Southern California
Los Angeles, CA 90007

Dr. Charles Gettys
Department of Psychology
University of Oklahoma
455 West Lindsey
Norman, OK 73069

Dr. Kenneth Hammond
Institute of Behavioral Science
University of Colorado
Room 201
Boulder, CO 80309

Dr. James H. Howard, Jr.
Department of Psychology
Catholic University
Washington, D.C. 20064

Dr. William Howell
Department of Psychology
Rice University
Houston, TX 77001

Dr. Christopher Wickens
University of Illinois
Department of Psychology
Urbana, IL 61801

Dr. Richard W. Pew
Information Sciences Division
Bolt Beranek & Newman, Inc.
50 Moulton Street
Cambridge, MA 02238

Dr. Hillel Einhorn
University of Chicago
Graduate School of Business
1101 E. 58th Street
Chicago, IL 60637

Dr. John Payne
Duke University
Graduate School of Business
Administration
Durham, NC 27706

Dr. Baruch Fischhoff
Decision Research
1201 Oak Street
Eugene, OR 97401

Dr. Andrew P. Sage
University of Virginia
School of Engineering and Applied
Science
Charlottesville, VA 22901

Dr. Leonard Adelman
Decisions and Designs, Inc.
8400 Westpark Drive, Suite 600
P. O. Box 907
McLean, Va 22101

Dr. Lola Lopes
Department of Psychology
University of Wisconsin
Madison, WI 53706

Mr. Joseph G. Wohl
Alphatech, Inc.
3 New England Industrial Park
Burlington, MA 01803

Dr. Rex Brown
Decision Science Consortium
Suite 721
7700 Leesburg Pike
Falls Church, VA 22043

Dr. Wayne Zachary
Analytics, Inc.
2500 Maryland Road
Willow Grove, PA 19090

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