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Effects of Knowledge Types on Objective and Perceived Choice Performance

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Abstract

Two components of knowledge used in making choices are examined: alternative-specific knowledge and choice rule knowledge. The effects of these knowledge types, both singly and jointly, upon objective choice quality and perceived choice quality are examined in two studies. The results of Study One indicate that the knowledge types are differentially beneficial, and that subjects tend to be more overconfident about the perceived quality of their choices when they have alternative-specific knowledge than when they have choice rule knowledge. The hypothesis that this difference is due to subjects' greater awareness of alternative-specific knowledge, rather than rule knowledge, is examined and supported in Study Two.

EFFECTS OF KNOWLEDGE TYPES ON OBJECTIVE AND PERCEIVED CHOICE PERFORMANCE

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Knowledge is a frequent and desirable component of decision making for choice. Knowledge can be used to guide the acquisition and organization of relevant information and aid in the selection of an appropriate rule for evaluating options for choice. However, despite much research on decision making for choice, questions still remain. For example, can the knowledge that influences decision making for choice be classified into different types? If so, are some types more beneficial than others? Are decision makers aware of different types of knowledge? Do they recognize that one type may be more useful for making a choice of good quality than another type?

The research described in this paper addresses these questions about knowledge, building upon past research in decision making and problem solving. In subsequent sections of this paper we present a theory-based rationale for examining two types of knowledge that are relevant for making a choice: alternative-specific knowledge, i.e., knowledge about the alternatives, and rule knowledge, i.e., knowledge of a choice rule for integrating and evaluating information about alternatives. Empirical assessments of these two knowledge types and their effects on objective and perceived quality of choice are obtained with two studies. The results of these studies indicate that the knowledge types are differentially beneficial, and that subjects tend to be more overconfident when they have alternative-specific knowledge than when they have rule knowledge.

BACKGROUND

Anderson (1983) described knowledge as consisting of declarative knowledge and procedural knowledge. Declarative knowledge consists of facts about the items in a problem space, such as the attributes of the alternatives in a choice problem, and the values of these attributes for different alternatives. Procedural knowledge reflects the skill component: knowing how to use the declarative information. The rules typically ascribed to decision makers for arriving at choices (e.g., elimination-by-aspects (Tversky 1972)) are examples of procedural knowledge. They direct the use of declarative information.

Newell and Simon (1972) describe a similar dichotomy with their distinction between representation and method for problem solving. The internal representation reflects the current situation for the decision maker. It is contained in a problem space, along with all other possible states of knowledge. The knowledge states are nodes, connected by processes. Processes are carried out by the activation of appropriate operators. If the internal representation enables the decision maker to select and apply a method, such as a choice rule in a choice problem, which, when executed, will achieve a desired end, the decision maker carries out the method. If no method is appropriate the decision maker changes the internal representation, adjusting it until a method can be retrieved and applied.

A third, similar distinction is made by Chi, Glaser, and Rees (1981) in their study of the development of expertise. They describe expertise as consisting of two components: a body of usable information and procedural skill. They suggest that what distinguishes experts from novices in any domain is that experts have the ability to convert knowledge of fundamental principles (as in physics problems) into procedures for problem solving. That is, a large amount of alternative-specific information will not automatically make a decision maker an expert decision maker. A lot of information may be useless unless the decision maker knows how to evaluate it.

The knowledge components described above are necessary for evaluating alternatives to make a choice. It must be noted, however, that the choice process exists beyond the stage of evaluating alternatives. For example, consider the process model depicted in Figure 1. The stage of Need Recognition may necessitate knowledge about needs and satisfactory goals. Information Search to identify alternatives requires knowledge about existing alternatives. These knowledge types may differ from the types of knowledge required to evaluate alternatives and to select one alternative. We focus on the evaluation stage, in which we propose that two types of knowledge are required. These types, alternative-specific knowledge and rule knowledge, reflect the dichotomy proposed by Anderson. Both types of knowledge can exist independently of the other. Therefore, we study the relative impact of these knowledge types on objective and perceived choice quality.

Figure 1 about here.

Separation of Knowledge Types

Much attention has been focused on understanding how the amount and structure of information in long-term memory influences choice performance (Bettman 1986). For example, consumer researchers have looked at the effects of product knowledge on information search (Bettman and Park 1980; Brucks 1985; Srull 1983), and on evaluation processes (Sujan 1985). However, alternative-specific knowledge, while undoubtedly useful, is not the sole contributor to superior choices. One may abstract general choice rules which can be transferred from one domain to another. To understand this, consider a choice situation. There are typically two tasks associated with a choice. One task is the extraction of relevant information about alternatives from the environment. The other task is the application of a particular choice rule to this relevant information, and the selection of the alternative that offers the highest utility to the decision maker. These two tasks need not be sequential. In some situations, the choice rule may be selected first, and then used as a template for guiding information acquisition (Bettman and Kakkar 1977; Lussier and Olshavsky 1979). In other situations, information may be acquired prior to selection of an evaluative rule (Biehal and Chakravarti 1982). Sometimes the two tasks may even occur simultaneously, as when a decision maker constructs a choice rule at the time of information evaluation (Bettman and Zins 1977; Hayes-Roth and Hayes-Roth 1979).

That choice rules can be developed and used independently of alternative-specific information is supported by research on problem-solving abilities in psychology. Anzai and Simon (1979) develop a theory of 'learning by doing', in which they argue that people learn which rules are most appropriate for problem solving in a particular domain by a process of trial and error. Anzai and Simon draw a clear distinction between knowledge of alternative-specific information (such as familiarity with the problem representation) and the processes used to solve the problem (described as the general learning capabilities of their model)[1]. This means that one can learn a rule in one domain, and then retain knowledge of that rule for use in a different domain. Anzai and Simon refer to this type of strategy as one that is 'task independent'. This depiction is consistent with earlier work by Newell and Simon (1972), who describe two main elements of problems and their solution: the representation of information and the method used to process it. The method can be specified independently of task information and can be used to process a variety of task information.

The implications of task separation in knowledge development are important. For example, in many situations people are passively exposed to information without a goal for encoding information (e.g., exposure to advertisements). Some of the information may be encoded in long-term memory (Gordon and Holyoak 1983). Consequently, over a period of time a decision maker can become knowledgeable about the alternatives in a particular category without necessarily becoming proficient at making good quality choices among the alternatives. For example, a decision maker might learn product information, but not develop any sense of attribute importance in the absence of a need to evaluate the alternatives. Alternatively, a decision maker making a choice in one category may develop

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[1]Anderson (1983) describes a similar process.

a choice rule that can be used to make a choice in another category. Thus, decision makers can have knowledge of alternatives without having the procedural skill of a choice rule, or vice versa. This view of knowledge is represented in Figure 2. Decision makers who have both alternative-specific knowledge and rule knowledge would be classified as experts (Cell 4). Decision makers with neither type of knowledge would be classified as novices (Cell 1). The decision makers who have alternative-specific knowledge, but not procedural knowledge, such as a choice rule, would be found in Cell 2. Decision makers with rule knowledge, but not alternative-specific knowledge, would be found in Cell 3.

Figure 2 about here.

This framework extends previous research by directly focusing upon the stages between being a novice and being an expert. We propose that the inclusion of two intermediate categories between those of novice and expert more realistically depicts the range of knowledge that may be possessed by decision makers.

In the studies described below, we examine the behaviors of decision makers in the gray area between being a novice and being an expert. Our goal is not to establish that decision makers obtain expertise by passing in order through the four cells, but to understand the two intermediate stages and the differences between them. To do so, we focus on the systematic differences between alternative-specific knowledge and rule knowledge. In the next section, we present hypotheses about the nature of outcome performance, or choice quality, and the decision maker's perception of performance, with respect to the presence and/or absence of these two components of knowledge.

HYPOTHESES

There are two key aspects of knowledge that are worthy of attention. One is the possession of knowledge by decision makers and the other is the recognition that knowledge is possessed. We propose that in route to becoming experts, decision makers not only develop a knowledge base, but that they also become aware of this growing knowledge base, which gives them more confidence in their decisions. While the existence of a broader knowledge is expected to manifest itself in choices of superior quality, it is the awareness of the knowledge base that is expected to influence perceptions of the quality of the choice.

In this section, hypotheses about the influence of alternative-specific knowledge and of rule knowledge are presented. The effects of these components, both singly and together, are predicted in terms of objective and perceived choice quality. Objective choice quality is simply how good the chosen alternative is, compared with other, not chosen, alternatives. Perceived choice quality refers to the decision maker's perceptions of the choice quality.

Objective Choice Quality

Psychology research in expertise suggests that experts have greater access to strong methods (i.e., procedures or rules) for solving problems, such as making good choices, than do novices, who rely on weak methods (Langley, Simon, Bradshaw and Zytgow 1987; Sweller, Mawer and Ward 1983). For example, in physics problem-solving, these stronger methods make use of axioms or fundamental principles to solve problems (Chi, et al. 1981; Larkin, et al. 1980). Novices use weaker methods, such as relying on superficial aspects of the problem, to guide solution attempts. These weaker methods often lead to inferior solutions. For decision making, the idea of weak and strong methods suggests that a decision maker who has knowledge of an appropriate rule (a strong method) for integrating and evaluating information about alternatives will tend to make objectively better choices than a decision maker without rule knowledge. In the classification in Figure 2, decision makers in Cells 3 and 4 have knowledge of choice rules, whereas decision makers in Cells 1 and 2 do not. Therefore, despite knowledge of alternative-specific information, Cell 2 decision makers, who do not have knowledge of choice rules, will have to choose randomly or construct an appropriate choice rule, unlike decision makers in Cells 3 and 4, who simply have to retrieve an appropriate choice rule. Because a constructed choice rule does not provide the decision maker with any knowledge of how effective the rule might be (i.e., there is no past history of success), these *ad hoc* rules may tend overall to be less effective than retrieved rules. Therefore, we expect that decision makers in Cells 3 and 4 will objectively outperform decision makers in Cells 1 and 2.

It should be noted, however, that work on implicit learning (e.g., Gordon and Holyoak 1983) indicates that people do internalize information about patterns and structure of information, and that they may use this information to abstract rules for using information. Therefore, is it possible that Cell 2 decision makers, while attending to alternative information, may unconsciously abstract choice rules. Thus, decision makers in Cell 2 are expected to have an advantage over decision makers in Cell 1 in their ability to organize information. Therefore, we also expect that the objective performance of decision makers in Cell 2 should be better than that of decision makers in Cell 1.

Perceived Choice Quality

Alternative-specific knowledge and rule knowledge are also expected to influence perceptions about choice processes and outcomes. In general, we expect that the degree of perceived expertise will influence decision makers' perceptions of choice quality. In other words, decision makers who consider themselves to have a broad knowledge base will tend to rate their performance more highly than those who consider themselves to possess a more limited knowledge base.

Decision makers can assess their degree of self-expertise by looking at either external or internal indicators. The external indicators might be task-oriented, such as the quality of the choice (i.e., outcome feedback). Internal indicators might be person-oriented, such as the recognition that one possesses procedural skills for performing a task. In general, external indicators would be useful where the correctness or incorrectness of the outcome is unambiguous, as in situations where feedback is immediately available. In many choice situations, however, outcome feedback is not so readily available. In these situations, decision makers may rely more heavily on internal indicators, such as the recognition that they possess choice skills, or on process feedback, such as the effort expended in making the choice (Creyer, Bettman and Payne 1989).

There is some evidence that the internal indicators may be difficult to assess. Studies have shown that people who internalize procedural knowledge through practice at a task may not be aware or able to articulate that they possess such knowledge (Lewicki 1986; Lewicki, Hill and Bizot 1988). Rule knowledge may be encoded at a deeper level than alternative-specific knowledge, and thus may not be easily recognized. In contrast, people are more likely to be aware that they possess alternative-specific knowledge. Therefore, cell 2 decision makers, who have alternative-specific knowledge, are expected to see themselves as more expert than cell 3 decision makers.

Note that the interesting difference between predictions of objective and subjective performance lies in the predictions about cells 2 and 3. Cell 3 decision makers are expected to perform objectively better than cell 2 decision makers, but cell 2 decision makers are expected to perceive their performance more highly than cell 3 decision makers.

To summarize the expectations about performance, we believe that subjects with rule knowledge will outperform subjects without rule knowledge, regardless of alternative-specific knowledge. In terms of perceived performance, however, we expect that subjects with alternative-specific knowledge will overestimate their performance, placing greater value on this knowledge than is warranted. In addition, when only one component of knowledge is present, we expect that rule knowledge will prove more valuable than alternative-specific knowledge in terms of objective choice quality, but that alternative-specific knowledge will result in higher estimates of perceived performance than rule knowledge.

Performance Estimation Error Index

In addition to actual and perceived performance, a performance estimation error index can be developed to reflect the mismatch between objective and perceived choice quality. This measure is constructed by subtracting objective choice quality from perceived choice quality (Arkes, Dawes and Christensen 1986). This index is a measure of overconfidence. An index value greater than zero implies overconfidence in performance, whereas an index value less than zero implies underconfidence. Following the general arguments outlined earlier, we expect decision makers in cell 2 to be over confident and in cell 3 to be underconfident about the quality of their choices. We also expect that decision makers in cell 4, who presumably have the greatest awareness of the knowledge they possess, to be closest to zero, that is, least likely to be over- or underconfident.

METHOD

The hypotheses were tested in two studies. In both studies, subjects were undergraduates at a major midwestern university. All subjects received extra course credit for participating in the studies. Fifty-one subjects participated in the first study and ninety-seven participated in the second study.

Study One

Procedure and Design. Subjects completed a pencil and paper task which took approximately thirty minutes. The task consisted of two phases: a training phase and a test phase. The phases are described below.

The test phase was exactly the same for all subjects. Subjects were provided with information about four laptop computers on four attributes in a brand/attribute matrix. They were then asked to choose the best brand. Laptop computers were selected after pretesting indicated that subjects had very little knowledge of laptops. Unfamiliarity was necessary in order to establish a baseline of knowledge about the alternatives in the category. On a seven-point scale, the mean response for familiarity with the category was 2.74 (where 1 was Not At All Familiar and 7 was Very Familiar). The standard deviation was 1.64, and the median response was 2.00.

Prior to the test phase, subjects went through a training phase. The purpose of the training phase was to achieve the manipulation of the independent variables. Two independent variables were manipulated between-subjects: alternative-specific knowledge and rule knowledge. Each variable was manipulated at two levels (yes/no) resulting in four treatment conditions, each of which corresponded to a cell in Figure 2. Thus, there were four different training conditions. Each subject was assigned to one of the conditions. Subjects in condition one received neither alternative-specific knowledge nor rule knowledge (Cell 1). Subjects in condition two received rule knowledge but not alternative-specific knowledge (Cell 2). Subjects in condition three received alternative-specific knowledge but not rule knowledge (Cell 3). Subjects in condition four received both alternative-specific knowledge and rule knowledge (Cell 4).

The training phase consisted of five problems. In each problem, information on four brands was provided in a four-by-four brand/attribute matrix. Based on the information, subjects were given a task to complete before moving on to the next problem.

Figure 3 is a schematic representation of the training and the test phase for the four cells. Subjects assigned to Cell 1 were given information on four brands of microwave ovens and asked to judge the similarity of the brands in the training phase. It was expected that they would abstract a rule to judge similarities of brands by the end of five trials. It was also expected that they would obtain alternative-specific knowledge about microwaves.

In the test phase, then, these subjects would have neither rule knowledge for making a choice nor alternative-specific knowledge for laptop computers (because they were given microwave information).

Figure 3 about here.

Subjects assigned to Cell 2 were given information about four brands of microwaves and asked to choose the best brand in the training phase. This was expected to provide them with rule knowledge about making the best choice, but not with alternative-specific knowledge about laptops. Subjects assigned to Cell 3 were given information about laptops and asked to judge similarity between brands. Finally, subjects assigned to Cell 4 were given laptop computers and asked to choose the best brand in the five training trials.

The goal of the training phase was to provide subjects with an opportunity to abstract a rule. Anzai and Simon (1979) suggest that methods may be developed during multiple attempts to reach a goal. Therefore, subjects who have multiple opportunities to make a choice are more likely to abstract an appropriate choice rule than subjects who make a choice only once, in the test phase. Also, subjects who had multiple exposures to the product category were expected to develop familiarity with the relevant attributes and their values (Coupey and Nakamoto 1988).

Regardless of the condition, all problems were constructed to be comparable in the number of brands and attributes subjects saw. Each problem had four brands and four attributes. For the microwave problems, the attributes were interior capacity, number of power levels, wattage, and length of warranty. For laptop computers, the attributes were weight, number of programs, internal memory, and external memory. All attributes were selected from the sets of features used by *Consumer Reports* to rate microwaves and laptops.

Dependent measures. Two primary dependent measures were obtained: an objective measure of choice quality and subjects' perceived measure of choice quality. The objective measure was the rank order data of the subject's selected brand from the final four brands in the test problem (see Stone and Schkade (1992) for a similar measure of performance). The brands were ranked from the best to the worst using a weighted adding rule. This rule has been used in previous research (cf. Johnson and Payne 1985) to establish an upper end of choice performance The ranks were computed using the attribute weights obtained from each subject at the end of the test phase. These weights were multiplied with attribute levels, for all attributes of a brand. The resulting products were summed across each brand to obtain the total brand value. The brand with the highest value was ranked 1 (indicating best performance), and the brand with the lowest value was ranked 4 (indicating worst performance).

The perceived choice quality was simply the subject's own estimate of the rank for his or her chosen brand. Subjects were asked to check the statement that they felt reflected their choice quality: "I chose the best brand," "I chose the second best brand," etcetera. A lower value indicated a superior assessment of performance.

Results.

Objective Performance. A two-way analysis of variance with rule knowledge and alternative-specific knowledge as factors revealed a significant main effect of rule knowledge ($F(1,50) = 6.64$; $p<0.01$). Subjects who made choice decisions in the training phase outperformed subjects who made similarity judgments in the training phase (mean ranks of 1.7 and 2.36, respectively). There was no significant effect of alternative-specific knowledge ($F(1,50) = 0.04$; $p<0.83$), or the interaction effect of rule and alternative-specific knowledge ($F(1,50) = 0.03$; $p<0.85$). However, because there was an *a priori* theoretical basis for expecting that the cell means would differ in a predicted pattern, a statistical contrast of the means for cells 2 and 3 was performed (Winer, 1971, pg. 384). The contrast approached significance ($t = 1.66$; $p<0.10$), suggesting that knowledge of a choice rule may be more helpful in making good quality choices than knowledge about alternatives. This finding provides tentative support for the premise that it is essentially rule knowledge that results in superior performance.

Perceived Choice Quality. The results for perceived choice quality show that the pattern is the reverse of that found for objective choice quality; highest estimates of performance were given by subjects in cell 1 (mean = 1.25). Cell 2 subjects were next (mean = 1.56), followed by cell 3 subjects (mean = 1.60). Subjects in cell 4 (the experts) gave the lowest estimates (mean = 2.00).

A two-way ANOVA with rule knowledge and alternative-specific knowledge as factors revealed a significant main effect of rule knowledge ($F(1,50) = 4.86$; $p < 0.03$); subjects with rule knowledge (mean = 1.83) perceived their performance more negatively than those with no rule knowledge (mean = 1.43). There was also a significant main effect of alternative-specific knowledge ($F(1,50) = 4.0$; $p < 0.05$); subjects with alternative-specific knowledge assessed their performance more negatively (mean = 1.76) than subjects without alternative-specific knowledge (mean = 1.41). The interaction effect was not significant ($F(1,50) = 0.06$; $p < 0.81$). The contrast between cells 2 and 3 was also insignificant ($t = .88$; $p < 0.88$).

Performance Estimation Error. An index of performance estimation error was constructed by subtracting perceived choice quality estimates from objective performance ranks[2]. In this index values greater than zero indicate overconfidence, and values less than zero indicate underconfidence. From the index it appears that cell 1 subjects were most overconfident (mean = 1.17), while cell 4 subjects were actually underconfident (mean = -.31). As hypothesized, cell 2 subjects (mean = 0.75) were more overconfident than cell 3

[2]Note that this measure is actually the negative of the overconfidence measure defined by Arkes et al. (1986). This was done to account for the fact that the performance indices in this study were ranks, where a higher value indicated a lower level of performance. By taking the negative of the Arkes et al. definition, we ensured that a higher performance estimation error reflected more overconfidence.

subjects (mean = 0.1). Cell 3 subjects were closest to predicting their performance levels accurately.

An analysis of variance with rule and alternative-specific knowledge as the between-subjects factors revealed a significant main effect of rule knowledge ($F_{(1,50)}$ = 13.06, $p < .0007$). The mean performance estimation error index for subjects without rule knowledge was 0.93, compared with -0.13 for subjects with rule knowledge. There was no significant effect of alternative-specific knowledge ($F_{(1,50)}$ = 1.97, $p < .16$), or of the interaction ($F(1,50) = 0.0002$; $p < 0.99$). The contrast between cells 2 and 3 was also insignificant ($t = 1.56$; $p < 0.13$).

The objective and perceived choice quality, as well as the performance estimation errors for Study 1 are summarized by cells in Figure 4.

Figure 4 about here.

Discussion. Study 1 enabled an examination of the benefits of alternative-specific knowledge relative to rule knowledge. The results of Study 1 indicate that being able to use a known choice rule, or procedural knowledge, appears to be more useful in making good choices than does alternative-specific knowledge. Subjects with alternative-specific knowledge have a small advantage over subjects who have neither rule nor alternative-specific knowledge. Moreover, having rule knowledge, even in the absence of alternative-specific knowledge, is still more beneficial than just alternative-specific knowledge.

Limitations. Two different rationales, one theoretical and one procedural, may explain this finding. First, subjects with rule knowledge may have used information more consistently than subjects without rule knowledge. This may have led to more compensatory processing of attribute values, thereby resulting in better objective choice quality. Subjects without rule knowledge may not have been able to use, or even to construct, a compensatory rule very well. In essence, this rationale assumes that subjects with only alternative-specific knowledge either chose randomly, or that they attempted to construct rules on-the-spot. If the latter assumption is true, then the constructed rules were not as optimal for making choices as the rules abstracted by subjects from multiple choice episodes during the training phase.

The second possible rationale for why cell 3 subjects outperformed cell 2 subjects may lie in the experiment procedure. All of the stimuli were presented as alternative/attribute matrices. This format may have facilitated the use of a compensatory rule that promoted better choices more than it helped subjects learn and organize product information. One benefit of knowledge in developing expertise is that it may help the decision maker to structure information (Beattie 1983), in effect, to construct a useful representation of the choice. One limitation of Study 1 was that the manipulation of alternative-specific knowledge did not enable examination of this representational benefit of knowledge.

A second factor which limits the conclusions which may be drawn from this study is the lack of control over rule abstraction. For example, subjects in cells 1 and 2 might have developed choice rules on the final decision. There was no time limit imposed, so subjects may have tried out different methods for evaluating brands, perhaps using process feedback, such as effort (Creyer et al. 1989), as a guide until an acceptable rule was developed. Thus, having unlimited time to try out rules may have enabled subjects in cells 1 and 2 to acquire some of the procedural skills presumed to be available only to subjects in cells 3 and 4. In general, the differences between objective performance in the four cells were small. Although the cell means follow the predicted pattern for objective performance, we cannot unequivocally state that the observed differences are systematic and would not change with changes to the manipulations or the inclusion of additional controls.

Finally, while this study was designed to facilitate comparison of rule knowledge and alternative-specific knowledge in cells 2 and 3, it could not be used to examine the effects that awareness of rule knowledge might have on perceived performance. Subjects with rule knowledge may not have recognized that they had a useful rule, obtained through repeated exposures. Work on implicit learning (e.g., Reber 1976) suggests that knowledge -- as of a rule -- and the ability to use it, may often precede awareness of the knowledge and the ability to verbalize it. Thus, it is expected that subjects who are aware that they have an appropriate rule for making a choice will be more confident in their choices than subjects who are not made aware that they have an appropriate rule for choice.

A second study was designed to examine the role of awareness on perceived choice quality, and to address the limitations discussed earlier. To this end, changes were made to the manipulations of alternative-specific and rule knowledge, the format of the stimuli, and the procedure used to collect the data.

Study Two

Procedure and Design

Subjects completed a paper and pencil task which took approximately thirty minutes. As in Study One, subjects made a brand choice and ranked their perceived performance.

The study was a 2x2 between-subjects design. The independent variables of alternative-specific information and rule knowledge were manipulated, resulting again in four treatment conditions. However, in order to address the limitations of the first study described above, and to assess the impact of awareness of a knowledge component on choice behavior, both manipulations were altered as described below.

The alternative-specific knowledge manipulation was changed primarily in two ways. First, subjects did not develop alternative-specific knowledge repeated exposure. Second, the alternative/attribute training format was discarded. Instead, to provide a more stringent and realistic assessment of the benefits of alternative-specific knowledge, subjects in the alternative-specific knowledge condition received a one page description of the product category, laptop computers. Without referring to specific brands, the page detailed which attributes were relevant for making good choices, and the usual ranges and most typical values of the attributes. Six attributes were used: memory, battery life, weight, disk speed, screen quality, and whether the laptop had a monitor port. Information about which attributes were not diagnostic was also provided. For example, statements such as, "Weight of the laptop computer is also important, but because all laptops tend to weigh pretty much the same amount, this information is not helpful in making a choice," were included. Subjects in the no alternative-specific knowledge condition were given a page of information of the same length and complexity, but for microwave ovens. In both conditions, the test phase required subjects to make a choice among laptop computers.

The second change to the alternative knowledge manipulation was in the presentation of the test stimulus. Rather than presenting the information in matrix form, the information was presented in paragraph form, one paragraph per brand. This presentation better reflects the way information about products is encountered in many purchase decisions, both in terms of the sequential, brand-by-brand nature of information availability, and in terms of the structure of the information about attributes and their values.

In order to assess the impact of being aware of a choice rule on choice quality and perceptions of the choice, the rule knowledge manipulation was also changed. One-half of the subjects (rule knowledge condition) were trained in the use of a choice rule that they were told would result in the selection of the best overall brand, if used correctly. The remaining subjects (no rule condition) were given no training.

Subjects in the rule knowledge condition were taught to use a simple choice rule. The rule consisted of the following steps. First, the subjects had to rank order the brands on each attribute from 1 (the best) to 4 (the worst). Second, subjects were asked to sum the ranks across the brands. The brand with the lowest total score was the best brand. This strategy was selected because of its intuitive appeal and simplicity; moreover, because the rule is compensatory, it is a reasonably normative method for making a choice. The test stimulus was constructed so that one brand was always the clear winner under this strategy. In addition, the stimulus was constructed so that the brand rankings obtained with this strategy would be the same as those obtained using a more complex weighted-adding strategy. Note that this manipulation should result in an objective performance advantage for subjects in the rule knowledge condition, thus limiting conclusions that may be drawn about the performance of subject with rule knowledge relative to the performance of subjects with alternative-specific knowledge. In contrast to Study 1, the goal of Study 2 is to examine the effect of knowledge awareness on overconfidence, the influence of the two knowledge types. Thus, attention here is focused on subjects' perceptions of performance when a ceiling for objective performance is induced by rule training and when subjects are made aware that they have an appropriate rule.

A time limit was also imposed on all subjects. The time limit was introduced to reduce the possibility that subjects in the no rule condition had sufficient time to construct a rule during the test phase. The time limit was determined in a pretest by obtaining an average of the response times for subjects adept in the use of the summed ranks rule. The average, two and one-half minutes, was used as a cut-off time in all conditions. Subjects were not told that there was any time constraint before they began the test phase. When time ran out, subjects were asked to make a choice immediately, and the experiment was ended.

Results.

Objective Performance: Manipulation Check. The results of a two-way analysis of variance served as manipulation check on the rule knowledge manipulation. There was a significant effect of rule knowledge ($F(1,96) = 34.46$; $p < 0.0001$). Subjects who were taught the rule significantly outperformed those who were not taught the rule (mean choice ranks were 1.53 and 2.86, respectively). Therefore, the rule manipulation was successful.

A contrast between cells 2 and 3 on the dependent measure of objective choice quality was also significant ($t = 3.72$, $p < 0.003$), thereby replicating the finding from Study 1. The overall performance pattern largely mirrored that observed in Study 1; subjects in cell 1 performed worst (mean = 2.96), followed by subjects in cells 2 (mean = 2.76), 3 (mean = 1.56), and 4 (mean = 1.5).

Perceived Choice Quality. The results of a two-way ANOVA with perceived performance as the dependent measure were used to examine expectations about the effect of awareness of rule knowledge on performance. Rule knowledge did have a significant effect on subjects' perceptions of their performance ($F(1, 96) = 3.99$; $p < 0.04$). As predicted, the pattern of perceived performance reversed from Study 1 to Study 2. In Study 2, subjects who were trained in the use of a rule, and who were aware of its benefits, not only made better choices objectively, but also had confidence in the quality of their choices. Subjects with rule knowledge and awareness of such knowledge had a mean perceived performance of 1.32, compared with 1.50 for subjects without rule knowledge. Recall that for Study 1, the comparable values were 1.83 and 1.43.

There was no significant effect of alternative-specific knowledge ($F(1, 96) = 0.08$; $p < 0.78$), but the interaction effect approached significance ($F(1, 96) = 3.14$; $p < 0.08$). The pattern of means was roughly the reverse of that observed in Study 1. Subjects in cell 1 ranked their performance lowest (mean = 1.6), followed by subjects in cell 2 (mean = 1.4). Contrary to expectations, however, subjects in cell 3 ranked their performance more highly than subjects in cell 4 (means of 1.26 and 1.38, respectively). A contrast of the difference between subjects in cells 2 and 3 was not significant ($t = 0.88$; $p < 0.38$).

Performance Estimation Error. The results were fairly consistent with those obtained in Study 1, and again provided support for predictions about overconfidence. Subjects in cells 1 and 2, with means of 1.36 each, were most overconfident about their performance. As expected, subjects in cell 3 (mean = .30) were less confident than subjects in cell 2. Cell 4 subjects were the least overconfident (mean = 0.12). Despite an insignificant interaction of rule knowledge and alternative-specific knowledge ($F(1, 96) = 0.52$; $p < 0.47$), the contrast of the means for cells 2 and 3 was significant ($t = 2.96$; $p < 0.004$).

A two-way ANOVA also revealed a significant effect of rule knowledge ($F(1, 96) = 20.38$; $p < 0.0001$). The mean for subjects without rule knowledge was 1.36, compared with 0.21 for subjects with rule knowledge. Subjects without rule knowledge were overconfident, whereas subjects with rule knowledge were less overconfident. Alternative-specific knowledge did not have a significant effect on overconfidence ($F(1, 96) = 0.12$; $p < 0.72$).

These results of Study 2 are summarized in Figure 5.

Figure 5 about here.

Discussion. Study 2 examined the effects of knowledge awareness on choice performance. It also addressed several design limitations of Study 1; subjects were presented with more realistic stimuli, and a time-limit was imposed to more effectively manipulate rule knowledge.

The results of Study 2 are similar to those of Study 1, with the exception of the results for perceived performance. The similarity in result patterns across cells, given the differences in independent variable manipulations, lends strength to the assertion that there are two independent knowledge components operating in the evaluation stage of the choice process: rule knowledge and alternative-specific knowledge. The relative influence of these knowledge types on perceived performance appears to differ primarily as a function of rule awareness.

Making subjects aware of an appropriate rule for making a choice has an effect on perceived performance. In Study 1, subjects without an opportunity to develop a rule over repeated exposures to the product category rated their performance more highly than those subjects with such an opportunity. In Study 2, the pattern reverses; subjects trained in the use of a rule rated their performance more highly than those not trained in rule use.

The Performance Estimation Error index suggests that one effect of rule awareness is to make subjects better able to judge their choice performance. Subjects without the rule training tended to be significantly less able to gauge their performance, and they tended to be more overconfident than subjects with the rule training.

GENERAL DISCUSSION

These two studies reveal a broader view of the knowledge components influential in choosing alternatives than has been previously addressed. In this paper, knowledge in the evaluation stage of the choice process has been conceptualized as a multi-stage process in which decision makers can have varying levels of knowledge. This contrasts with previous approaches in which decision makers have tended to be categorized as either novices or experts. Independent manipulation of the two knowledge components, rule knowledge and alternative-specific knowledge, provides insights into the relative benefits of each knowledge type. A focus on the objective and perceived performance as a function of combinations of these two knowledge types enables conclusions about possible remedies for overconfidence in choice behavior.

To summarize, alternative-specific knowledge is defined as knowledge specific to the category in which a choice is being made. This includes knowledge about the attributes relevant for making choices, and the usual ranges and most typical values of these attributes. This type of task-specific knowledge is relevant only to choices being made from a particular category.

Rule knowledge is defined as task-general knowledge. This type of knowledge may consist of general choice rules that a decision maker can apply to a variety of choice situations. An example of rule knowledge is knowing how to use the weighted adding rule to evaluate alternatives. Rule knowledge can be applied to choice in any category.

These two knowledge components were used to conceptualize the various stages of knowledge for making a choice. By treating each knowledge type as a dichotomous variable, four unique stages of knowledge were described. Two studies were conducted to assess the validity of this conceptualization, by examining subjects' performance on both objective and perceived choice quality.

The findings were generally consistent with the hypotheses. Rule knowledge tended to result in superior objective performance, whereas alternative-specific knowledge led to superior perceived performance. Interestingly, subjects with neither rule nor alternative-specific knowledge, and who performed the worst objectively, also tended to perceive their performance as being the best. It appears that one aspect of knowledge is the development of a more realistic assessment of one's performance. This was demonstrated by the performance estimation error index.

The analysis of the performance estimation error index, obtained by subtracting perceived performance from objective performance, showed that, in both studies, Cell 2 subjects (alternative-specific knowledge, no rule knowledge) tended to be more overconfident than Cell 3 subjects (rule knowledge, no alternative-specific knowledge). A possible explanation for this finding may lie in the accessibility of the knowledge component. Alternative-specific knowledge may be more accessible than rule knowledge, which may be more deeply encoded. Some support for this view was found in Study Two. When subjects were made aware that they possessed rule knowledge, their perceived choice quality increased.

<u>Limitations</u>

Several limitations to this research must be noted in order to evaluate the contributions. First, both experiments were conducted in artificial, laboratory settings. Rather than measuring subjects' knowledge of the stimulus category, we opted to use a category with which most subjects were unfamiliar, and then observe the growth of knowledge and its effects on performance. The disadvantage to this approach is that acquisition of the knowledge types of interest may not perfectly reflect the way knowledge is accumulated over time and used in everyday decisions. This shortcoming may be particularly true in subjects' use of attribute weights. Even with multiple exposures, subjects may not have internalized and used attribute weight information in the same way as they would use preferences for attributes developed over time and experience. The alternative, however, had disadvantages that we deemed to outweigh any advantages. For example, it is not clear how to accurately estimate the amount and structure of prior knowledge a subject might bring to a choice task. Some subjects may store information in previously made overall evaluations, while others might store attribute-level information. These different storage techniques may be confounded with rule knowledge acquired in previous exposures to the category. Thus, a trade-off was made of realism for control.

The same trade-off was made in the manipulation of rule knowledge. Rule knowledge was achieved in Study 1 by exposing subjects to five choice situations and in Study 2 by teaching subjects a choice rule. In reality, decision makers probably abstract rules by a combination of the two methods, i.e., by making repetitive choices and learning choice rules from others. Moreover, decision makers in real life probably have a repertoire of choice rules with a mega-strategy, sensitive to situational constraints (e.g., time pressure), that tells them when to use which choice rule.

The second limitation to be noted is the assumption that optimal choice is predicted by a multiattribute, weighted adding rule. Although such rules are commonly used in decision research, they do have constraints. First, they cannot reflect cutoffs a decision maker might have for minimally acceptable levels of an attribute. Second, these types of rules are misleading if the attributes are correlated (e.g., miles per gallon and size in automobiles). Because we used a category with which subjects tended to have no familiarity, however, these issues were less problematic.

Despite these limitations, the studies described in this paper provide several insights into types of knowledge and their influences on objective and perceived performance. In the following section, a discussion of the conclusions and their implications is provided.

Conclusions

Three main conclusions may be drawn from the results of this research. These are: 1) that knowledge can be described as a multi-stage process, 2) that knowledge may influence objective choice quality, but awareness of knowledge influences perceived choice quality, and 3) that constructive processes are ubiquitous in the development of knowledge for making choices.

Knowledge as a Multi-type Process. In this paper, knowledge has been described as consisting of several types, from being a novice to being an expert, although evidence is only provided for four discrete types. Decision makers may not pass through these types in order. As we demonstrate in Study 2, simultaneous presentation of rule and alternative-specific knowledge can create instant experts. Mere knowledge that these different types may exist, however, can be used by both decision makers and those who present information to decision makers. By recognizing the characteristics which identify one as a member of a particular knowledge category, and by knowing the advantages and limitations of each category, information presentations can be tailored for more effective choice behavior.

Knowledge and Awareness. The results of Studies 1 and 2 indicate that while knowledge influences the quality of choice, it is the awareness of knowledge that affects the decision maker's confidence in the choice. This has important ramifications for public policy makers. For example, consider the finding that objective and perceived performance are inversely related unless decision makers are aware of their knowledge. Building on the conclusion above, the potential for unsatisfactory choices can be reduced by making decision makers in Cells 1 and 2 aware that they are likely to overestimate the quality of their choices.

Constructive Processes. Recently, research in several areas has focused on the constructive development of preferences and the strategies used to determine these preferences (Payne, Bettman, Coupey, and Johnson 1992). The results of Study 1 underscore the ubiquity of constructive processes, as they suggest that decision makers without the opportunity to retrieve or develop choice rule during a training phase may construct choice rules in a single test case, when given ample time. Because no outcome feedback was provided, the decision maker's decision to stick with a constructed rule must be driven be internal indicators of performance (i.e., process feedback, such as effort). That subjects in the no rule condition perceived their choices to be higher in quality than subjects in the rule condition suggests that the higher amounts of effort presumably required of no rule subjects in the test case may be used as proxies for accuracy. Paese and Sniezek (1991) describe a similar finding of effort as a proxy for accuracy in a judgment task. Further research should consider the effect of rule awareness as a mediator of these effort/accuracy proxies.

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Figure 1

A PROCESS MODEL OF CHOICE

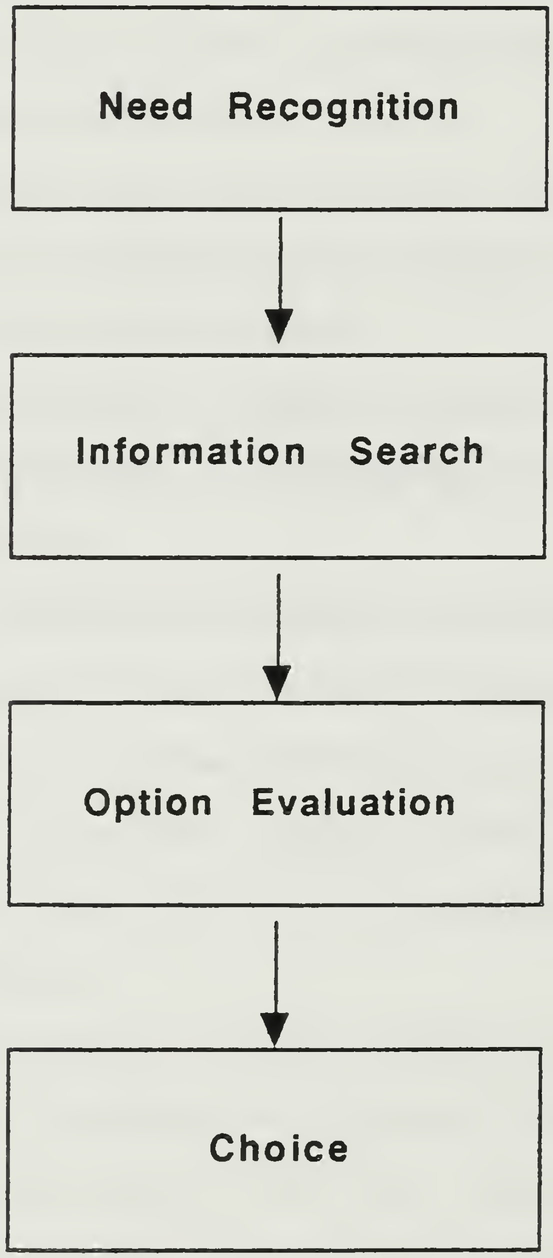

Figure 2

		ALTERNATIVE-SPECIFIC KNOWLEDGE: NO	ALTERNATIVE-SPECIFIC KNOWLEDGE: YES
RULE KNOWLEDGE	NO	1	2
	YES	3	4

Figure 3

STUDY 1: SCHEMATIC REPRESENTATION

		CELL 1	CELL 2	CELL3	CELL 4
TRAINING PHASE	**Product Category**	Laptop computers	Laptop computers	Microwave ovens	Microwave ovens
	Task	Judge similarity of brand pairs	Judge similarity of brand pairs	Choose best brand	Choose best brand
TEST PHASE	**Product Category**	Microwave ovens	Microwave ovens	Laptop computers	Laptop computers
	Task	Choose best brand	Choose best brand	Choose best brand	Choose best brand

Figure 4

ALTERNATIVE-SPECIFIC KNOWLEDGE

RULE KNOWLEDGE	NO	YES
NO	1 N=12 OBJECTIVE: 2.42 PERCEIVED: 1.25 OBJ-PER: 1.27	2 N=16 OBJECTIVE: 2.31 PERCEIVED: 1.56 OBJ-PER: 0.75
YES	3 N=10 OBJECTIVE: 1.70 PERCEIVED: 1.60 OBJ-PER: 0.10	4 N=13 OBJECTIVE: 1.69 PERCEIVED: 2.00 OBJ-PER: -0.31

Figure 5

ALTERNATIVE-SPECIFIC KNOWLEDGE

RULE KNOWLEDGE	NO	YES
NO	1 N=25 OBJECTIVE: 2.96 PERCEIVED: 1.60 OBJ-PER: 1.36	2 N=25 OBJECTIVE: 2.76 PERCEIVED: 1.38 OBJ-PER: 1.36
YES	3 N=23 OBJECTIVE: 1.57 PERCEIVED: 1.27 OBJ-PER: 0.30	4 N=24 OBJECTIVE: 1.50 PERCEIVED: 1.44 OBJ-PER: 0.13