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THE EFFECTS OF EXPERTISE AND INFORMATION RELEVANCE ON INFORMATION SEARCH STRATEGY

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Differences between experts and novices have been the focus of a variety of studies throughout the psychological literature. In general, task outcome differences have been found between experts and novices, but further study is needed to understand the mechanism for explaining these outcome differences. This study investigated task-processing differences between experts and novices, specifically, the use of relevant and irrelevant information. Forty human resource professionals served as experts and 40 undergraduate students served as novices in this study. Participants made two hiring decisions. Using an information board format, participants examined eight attributes across six candidates for the job of museum curator and chose the applicant they believed would perform the best. It was hypothesized that experts would be better able to ignore irrelevant information than novices. An interaction between expertise and information relevance was found such that experts searched less information than novices during a decision task in which both irrelevant and relevant information is present (low relevance condition). Novices did not differ in the quantity of information searched as a function of information relevance. To test an exploratory hypothesis, chi-square analyses were used to examine the use of compensatory versus noncompensatory search strategy by experts and novices. Experts adjusted their use of search strategy based on the relevance of information presented, while novices tended to use a noncompensatory search strategy

regardless of information relevance condition.

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THE EFFECTS OF EXPERTISE AND INFORMATION RELEVANCE ON INFORMATION SEARCH STRATEGY

Overview of the Problem

The world relies on experts. Thinking back on the events of the past few days surely provides evidence for impact that experts' decisions and actions have on your life. Did you watch the weather forecast on television during breakfast? Take a commercial flight? Use a computer at school or work? Call or visit a physician, accountant, or attorney? Experts help us deal with the enormous body of knowledge and information that is a product of the information age in which we live. Experts are given the authority and opportunity to make important decisions because it is generally assumed that they make better decisions than novices.

A body of psychological research has shown the superiority of experts over novices in arriving at an outcome. In addition, this body of research has documented differences in the processes that experts and novices use to arrive at outcomes. Expertise has been studied in a variety of domains, yet the concept of expertise needs to be investigated in more domains and contexts to gain a better understanding of the differences between experts and novices.

The purpose of the current investigation is to examine particular task processing differences between experts and novices. It is important to examine the task process differences between experts and novices, in addition to task outcome differences, for several reasons. First, if there are task outcome differences between experts and novices, it is important to know why those differences exist so that we may understand how to

help novices "behave" more like experts. An understanding of such differences could have far reaching impact on training given that it may be possible to demonstrate to novices the strategies or tools necessary to help them become more like experts. In addition, even if there are no significant differences between experts and novices in arriving at task outcomes, it is still important to identify possible task process differences. Why? If experts, for example, are faster and more efficient than novices, there are practical benefits to having such experts arrive at outcomes.

Outline

The first portion of the introduction provides a discussion of existing definitions of expertise. Next, a summary of studies focusing on task outcome differences between experts and novices is provided. The review of previous literature then turns to studies in which the task performance processes of experts and novices are compared. These studies are organized according to the specific task performance processing domain being measured. Finally, a description of the current investigation and several research hypotheses are offered.

Defining Expertise

As with research on any topic, an initial goal is to identify the key components of the construct under consideration. Within the expertise literature, a variety of definitions have been suggested. Given the lack of a unified definition of expertise within the literature, it is necessary review the various views of expertise to identify the common themes that exist across the different conceptualizations of the construct. The current

section outlines the existing definitions of expertise and discusses the two major themes that emerge from these definitions.

A useful way to begin a discussion of the construct of expertise is to look at the opposite end of the expertise spectrum and identify what an expert is *not*. Two groups of researchers have specifically addressed the issue of defining a novice. Shanteau and Stewart (1992) identify three stages that exist within the process of expertise acquisition. They suggest three stages within the expertise acquisition process, naïve, novice, and expert. Naïve decision makers are defined by Shanteau and Stewart as those with no experience or skill in a particular area. Novices have some skill and knowledge in an area but cannot perform at an expert level.

A second group of researchers, Hoffman, Shadbolt, Burton, and Klein (1995), offer a framework for the acquisition of expertise that is similar in some respects to the view offered by Shanteau and Stewart. Using terminology borrowed from the Middle Ages, Hoffman et al. (1995) suggest a "guild taxonomy" to describe different stages in the process of becoming an expert, including naivette, novice, initiate, apprentice, journeyman, expert, and master. Under this hierarchy, the definitions of naivette and novice closely parallel Shanteau's naïve and novice stages. A naivette is defined as someone who is totally ignorant in a domain. A novice is defined as a person who is new to a domain and has minimal exposure to the domain.

To summarize, a novice is a person who has some limited knowledge, exposure, or experience in a domain. However, novices are not the least knowledgeable or

experienced individuals within a domain; there may be individuals who are completely naïve to a domain and know nothing or have had no exposure to a domain.

Given the preceding discussion of novices, a logical follow-up question is the following, "What exactly is an expert?" No unified definition of expertise exists within the literature, although definitions of experts and expertise have been offered by a number of prominent expertise researchers. These definitions are provided below.

Camerer and Johnson (1991) defined an expert as "a person who is experienced at making predictions in a domain and has some professional or social credential." (p. 196). Second, Chi, Glaser, and Rees (1982) defined expertise as "the possession of a large body of knowledge and procedural skill." (p. 8). Third, Ericsson and colleagues (Ericsson & Charness, 1994; Ericsson & Smith, 1991) offer two definitions of expertise, or to use their term, expert performance. Their first definition of expert performance is, "consistently superior performance on a specified set of representative tasks for the domain that can be administered to any subject (Ericsson & Smith, 1991, p. 731)." Ericsson and colleagues' second definition of expert performance is quantitative in nature and it states that expert performance can be considered to be any performance at least two standard deviations above the mean of the population.

Fourth, Hoffman, Shadbolt, Burton, and Klein (1995) define an expert as a person, "...whose performance shows consummate skill and economy of effort, and who can deal effectively with rare or 'tough' cases. Also, an expert is one who has special skills or knowledge derived from extensive experience with subdomains." (p. 132). Finally, Shanteau and Stewart (1992) suggested that experts should be operationally

defined as, "those who have been recognized within their profession as having the necessary skills and abilities to perform at the highest level." (p. 255).

Although there is a lack of consensus in defining expertise, two themes can be identified that are either explicitly or implicitly included in the definitions of expertise described above: a high level of performance and a high degree of knowledge. These two themes, performance and knowledge, are related to one another. The performance theme deals with the level at which a person is able to engage in an activity, play a sport or instrument, or make a decision, and the knowledge component is a characteristic that, in part, enables an expert to perform at a high level. A more detailed discussion of these two themes is the focus of the next section.

High Level of Performance

As indicated by the previous definitions of expertise, experts are presumed to perform at a higher level than novices. The idea that experts exhibit superior performance to novices is a prevailing common sense assumption outside of the research world as well. However, the type of performance varies greatly and the way in which performance is measured is dependent on the domain being examined. For example, the performance of a chess player may be compared using the win-loss records of competitions and the performance of a computer programmer may be measured by examining the ability to diagnose an error within a program.

Some expertise research has focused on the acquisition of expertise and its impact on performance levels. In many domains, a higher level of performance comes after a great deal of practice. The acquisition of expertise as it relates to practice and experience

in a domain has been studied by numerous researchers. Ericsson, Krampe, and Tesch-Romer (1993) interviewed experts and read diaries of experts in several domains in an attempt to better understand the process undertaken by individuals trying to become experts. A common denominator to all of the participants in the study, which included athletes, artists, and musicians, was a record of intense practice over an extended period of time. In fact, the amount of practice reported by participants as a whole, no matter what the domain, was surprisingly consistent. Experts reported practicing four hours consistently, meaning every day of the week, typically arranged in one-hour sessions followed by breaks.

Simon and Chase (1973) were interested in quantifying the amount of practice necessary to become an expert. They found that it may be possible to achieve expert status in some domains after several hundred hours of practice, but a much longer period of practice is required to gain expertise in other domains. In particular, they point out that most chess players who become experts do so only after thousands of hours of practice. In fact, from their extensive study of chess players, Chase and Simon (1973) indicate that at least 10 years of intense practice is usually necessary to reach the level of chess master. The 10-year period for expertise acquisition seems to hold true for other domains such as athletics (Hayes, 1981). To summarize, the high performance level of experts can, at least in part, be attributed to practice and experience in a domain.

In some domains, such as chess and athletic competition, the identification of people performing at a high level can be readily obtained by examining win/loss records or scores in competitions. However, in many other domains of expertise, the

identification of outstanding performance is not so apparent and available. For example, if we are interested in identifying expert accountants, there is no readily available record of their performance that we can examine to make a determination regarding their level of expertise. As a result, some researchers have relied on markers of social recognition or professional credentials to identify expert groups. In fact, Ericsson and Charness (1994) suggested that experts are identified less frequently through quantitative measures than they are through social recognition such as title or position.

The use of credentials and social recognition as a measure of expertise can be at least partially explained by the fact that obtaining expert participants for an experiment is a difficult task (Shanteau, 1988). Access to experts is difficult given that experts' specialized skill and value to their respective organizations make their time extremely valuable. Consequently, any method that can simplify the expert identification process makes studying experts more practical. However, drawbacks exist regarding the sole use of the social recognition or credentials approach for selecting participants. First, using such an approach is not a concrete, quantifiable measure of expertise. It is quite possible that a person with an advanced degree or prestigious title is not able to perform at an expert level in a given domain. It is unwise to assume that level of education or credentials necessarily provides an accurate indicator of expertise. Second, the particular type of social credentials used to select experts for studies varies from one domain to another. Results of studies are hard to compare when one study selected experts based on job title, one is based on level of education, and another is based on professional certification.

Even if performance level cannot be easily measured, an alternative quantitative measure of expertise exists. This alternative measure involves knowledge level, which is the second main theme of expertise definitions.

High Level of Knowledge

The most widely agreed upon and accepted assumption within the expertise literature is that an expert possesses a larger amount of domain knowledge than novices (Bedard & Chi, 1992). A domain is a broad term that can include professions such as accounting or medicine, playing of a musical instrument, or competitive events like games and athletics. As an example of an expert possessing a large amount of domain knowledge, it has been estimated that an expert chess player can recognize at least 50,000 different chess positions (Chase & Simon, 1973).

It must be emphasized that an expert's superiority of knowledge compared to a novice's is limited to a specific domain (Glaser & Chi, 1988). The limitation of experts outside their domain of knowledge was demonstrated in a study in which chemists and political science experts were asked to provide solutions to a problem about improving crop productivity in the Soviet Union (Voss & Post, 1988). The political science experts were much better able to solve the problem by identifying the major causes of the problem, using previous knowledge about the Soviet Union, and providing a case for why their solution would work. The chemists were proficient in solving a problem within the field of chemistry, but they were not as skilled as political science experts at solving a problem within the political science domain.

Although researchers generally agree that a high level of knowledge is a major component of expertise, evidence from two studies suggests that experts do not necessarily have a high level of general intelligence, as measured by IQ tests. Ceci and Liker (1986) conducted a study to determine whether or not IQ is significantly related to the predictive accuracy of expert horse race handicappers. Participants were: (a) asked to provide pre-race odds for horses entered in a series of hypothetical races, and (b) predict the top three horses in each race. The calculation of odds for each horse is a complex exercise that involves the consideration of a number of different factors, such as the horse's previous race record, race speed, and performance on various race track surfaces. The participants were provided with the same information they would normally have access to prior to a race, such as each horse's speed in prior races, race performance, race track sizes, and so forth. Each participant's IQ was measured using the Wechsler Adult Intelligence Scale. Ceci and Liker (1986) found a very low correlation ($r = .04$) between scores on the IQ test and the measure of performance accuracy. Based on this finding, the authors suggested that IQ is not related to handicapping expertise.

Ericsson, Chase, and Faloon's (1980) case study of recall ability also provides evidence that high IQ is not a prerequisite for expertise. They studied an undergraduate student who had an average score on an IQ test. The student engaged in a digit-span exercise, in which he was asked to repeat a sequence of random digits, for one hour three to five times per week. Over the course of a year and a half, the student's performance on the digit span test increased from 7 to 79 digits by the end of the study; a digit-span recall of 10 or more is considered to be exceptional. The results of this study suggest that

a person with an average IQ can become an expert on a memory task. Considered together, the studies by Ceci and Liker (1986) and Ericsson et al. (1980) provide evidence for the fact that experts do not necessarily score high on IQ tests.

Turning again to the issue of knowledge, a person's knowledge can be classified as either declarative or procedural in nature (Anderson, 1982). The declarative versus procedural knowledge distinction is made as part of Anderson's (1982) ACT* theory and it provides a useful framework for discussing the knowledge obtained by an expert. Declarative knowledge is factual knowledge. Procedural knowledge involves the process for how things should be done. According to ACT* theory, all knowledge is originally stored as declarative knowledge. Over time, some knowledge is converted to procedural knowledge. This theory suggests that after brief exposure in a domain a person may obtain some declarative knowledge, and with continued exposure to that domain, a person will accumulate more declarative and procedural knowledge. Research in the expertise literature has documented two information processing mechanisms, use of chunking and schemata as memory encoding mechanisms, that are used by experts to develop a large amount of declarative and procedural knowledge within a particular domain. These two mechanisms are described next.

Experts have the ability to process information and store it in larger, meaningful groups, or chunks (Glaser & Chi, 1988). A study of beginner, intermediate, and expert computer programmers was conducted to determine how expertise impacts the nature of information recall (McKeithen, Reitman, Rueter, & Hirtle, 1981). Beginners in the study were students who had just started a course in ALGOL W programming language.

Intermediates were students who had completed a course in ALGOL W programming language. Experts were instructors of courses teaching ALGOL W programming who had at least 200 hours of general programming experience.

In this study of computer programmers, participants were given a list of 21 words from the ALGOL W programming language and asked to commit them to memory. After successfully recalling all 21 words in two consecutive practice trials, participants were tape-recorded as they were asked to repeat the list of words 25 times. The order in which the words were recalled was analyzed. All words that were listed together, regardless of order, across all 25 trials were grouped together and considered to be a chunk. A comparison of the three group's recall patterns revealed that experts grouped words according to the meanings of the words in the ALGOL W language, and beginners relied almost exclusively on mnemonic techniques such as grouping based on the first letter. Participants in the intermediate group used a mixture of mnemonics and meaning-based groups.

A second strategy that experts use to process information is the use of scripts or schemata (Hershey, Walsh, Read, & Chulef, 1990). Scripts and schemas are pre-established mental strategies and encoding schemes that people have for performing cognitive functions. Expert and novice financial planners were studied using a verbal process tracing method as they made a decision about whether a hypothetical client should invest in an individual retirement account. Investigators tape-recorded comments made by the participants as they made their decision and analyzed the content of these comments. In this study, an indicator for the use of scripts was the number of total steps

and repeated steps required to make the decision. In other words, if a person used scripts or schemata to guide them in making a decision, he or she may have needed to examine less information than a person who did not use scripts for the same decision. The expert's use of fewer steps and fewer repeated steps than novices during the information search process suggested the use of scripts by experts.

In a study of physicists (experts) and physics students (novices), the contents of the participant's schemata were identified (Chi, Feltovich, & Glaser, 1981). Participants were asked to think aloud as they described the strategy that they would use to solve physics problems. The analysis of the protocols revealed that the schemata novices used contained some declarative knowledge, like the physical configurations of a problem, but experts' schema contained both declarative and procedural knowledge. The procedural knowledge possessed by the experts included possible methods or strategies for solving the problem.

Because experts are able to use efficient information-processing strategies such as chunking and scripts, it is also presumed that experts can search information faster than novices. This presumption will be addressed later in the introduction with a review of articles that have measured the information search speed of experts and novices.

So far, the domain specificity of an expert's knowledge, declarative and procedural knowledge, and efficient processing strategies have been discussed. However, the topic of how an expert acquires his or her knowledge has not yet been discussed. When performance was discussed earlier in this section, the topic of practice was considered. Practice or experience in a domain helps experts achieve high levels of

performance. Similarly, practice or experience in a domain is what allows a person to obtain high levels of knowledge. However, it should be noted that the knowledge obtained by an expert is derived from a variety of paths not limited simply to practice. For example, consider the knowledge that an expert pilot may possess. Some of that knowledge may have been obtained in an academic context through flight school courses. Other knowledge may be obtained from actual on-the-job experiences. Practice using a simulator or other types of training may provide yet another source of knowledge. The overall point to be taken from this example is that the procedural and declarative knowledge an expert possesses may be derived from a variety of contexts. Regardless of the source of the knowledge, the knowledge base represents one indicator of an individual's level of expertise.

To summarize, in this section, I have presented evidence for why knowledge is a major component of the expertise construct. First, I noted that experts possess more domain-related knowledge than novices. In addition, it appears that experts are able to organize knowledge using chunks and store both declarative and procedural knowledge within schemata or mental scripts. I also discussed that the knowledge of an expert can be obtained from a variety of contexts.

Overall, in the current section of this literature review, I have examined the construct of expertise in terms of definitions and major themes. Expertise is a construct lacking a unified definition; however, researchers generally agree that a high level of performance and a large amount of domain knowledge are essential components when characterizing experts. The information outlined in this section provides a helpful

introduction to the topic of expertise, but a proper understanding of the expertise literature is incomplete without a review of key research findings.

The next section provides a review of studies comparing experts and novices, specifically those studies primarily focused on task outcomes. However, task process differences will be discussed in studies where they were found, as well. This section reviews research in the domains of chess, computer programming, physics, clinical psychology, graduate school admissions, real estate appraisal, and medicine. These studies are organized according to the type of task outcome studied. The subsequent section will review studies where task process differences were the primary focus.

Task Outcome Differences between Experts and Novices

Recall Ability as Outcomes

Chess Players. de Groot (1965) was the first to study the differences in task outcome abilities of experts and novices. de Groot, who was himself a chess master, was interested in the recall abilities of expert and novices chess players. Experts in his study were considered chess masters, defined using the skill guidelines set forth by chess competitions. Novices in the study were players at a level below master. The task in this study involved reconstructing two types of chessboard configurations after viewing the board for five seconds. The first type of board configuration was a layout of pieces from a classic game previously played by chess masters. The second type of board configuration was a random, nonsense placement of pieces.

The measure of accuracy in the experiment was how many pieces were placed on the correct squares. Experts were able to reconstruct the classic game boards almost

perfectly, while novices made more errors. However, when presented a chess board with random placement of pieces, experts did not perform significantly better in the reconstruction task than novices. The results of this study suggested that chess masters have better memory abilities than novices, but only when presented with a familiar task.

Chase and Simon (1973) conducted a follow up to de Groot's study by comparing the performance of one expert, one intermediate, and one beginner chess player on a short-term recall task. The designation of expert, intermediate, and beginner was set forth by skill guidelines established for chess competitions, as in the de Groot (1965) study. Participants were presented with two chess boards: a board from a classic chess game and a random chess board. The experiment's measure of recall accuracy was how many chess pieces were placed on the correct squares.

The results of this study indicated superior performance on the part of the expert chess player. In the short-term recall task involving the classic board, the expert player correctly placed more pieces than either the intermediate or beginner player did. However, in the short-term recall task involving the random board, the expert chess player did not correctly place more pieces than either the intermediate or beginning player. The results of this study support the findings of de Groot regarding the superior recall ability of experts on familiar tasks.

Following the results obtained by de Groot (1965) and Chase and Simon (1973), researchers attempted to replicate expert versus novice differences in recall ability in other domains, such as computer programming and medicine.

Computer programmers. In the previously mentioned study of computer programmers (McKeithen et al., 1981), a memory experiment was conducted. Twenty-four beginner, 23 intermediate, and six expert programmers were shown a 31-line ALGOL W computer program for two minutes using an overhead projector. Half of the participants at each skill level were shown the program as it was written and half of the participants were shown a randomly scrambled list of code. The participants were given three minutes to write down as much of the program as possible from memory. The number of lines of code identified in the correct order was tabulated for each participant. A significant skill by program version interaction indicated that experts showed superior recall when working with the unscrambled version of the program. The difference between the expert's performance with the unscrambled program was significantly better

than intermediate or novice performance, but expert performance was not significantly better with the scrambled program.

In another study of computer programmers, Adelson (1981) compared five expert and five novice programmers' ability to recall code. Experts in this study were teaching fellows for an introduction to computer programming course. Novices were undergraduate students who had just completed an introductory course in computer programming. The participants were shown 16 lines of code. The participants were exposed to each line of code for 20 seconds. Following the presentation of all 16 lines of code, participants were asked to verbally recall as many lines of code as possible. This procedure was repeated nine times.

Two measures of recall were used in this study. First, the number of items recalled by each participant was calculated. The results of the study indicated that experts recalled significantly more lines of code. The second measure in the study was a task process measure in which the chunking strategies used by the participants were compared. Pauses were documented during the recall phase of the study and words recalled with less than a 10 second pause between them were considered to be a chunk. Using this measure of chunking, the expert's chunk size was greater than the novice chunk size.

Physicians. Patel, Groen, and Fredricksen (1986) compared the recall ability of physicians and medical students. Expert participants were six physicians specializing in internal medicine. The novice participants in the study were six second-year medical students.

Participants listened to an audiotape of one typical and one atypical medical case. How typical a case was depended on the difficulty involved in determining a diagnosis, the frequency a similar case is encountered, and how well the information in the case represented a specific disease. After listening to each case, subjects were asked to verbally recall as much information from the case as possible. The verbal protocols were transcribed and analyzed using the propositional analysis method, which involves breaking down protocols into segments that represent "chunks" of the subject's thoughts. The segments from the protocols were matched against the original case texts and segments were coded as either "recall", an exact match to information in the case, or "inference", a transformation of any kind made to the information in the case. The segments were also coded as either "disease relevant" or "disease irrelevant". The determination of information relevance was made by a panel of six physicians who read the cases and were asked to reduce the case text to less than one half of its original size, leaving only the most relevant pieces of information. The proportion of physicians who retained a piece of information provided an index of relevancy. Dependent measures in this study consisted of calculations of the percentage of disease relevant and irrelevant recalls and transformations made by the participants.

The results of the study indicated that differences exist in the types of information experts and novices recalled. For the typical case, novices recalled more than twice as many propositions as they inferred. For the atypical case, novices inferred more propositions than they recalled. Experts recalled and inferred approximately the same proportion of propositions for both typical and atypical cases.

Expert and novice's recall of disease irrelevant information provided an interesting comparison. Overall, novices recalled nearly twice as many nonrelevant propositions as experts. So, it appears that the experts were better able than novices to disregard irrelevant propositions during this recall exercise.

Coughlin and Patel (1987) conducted a study similar to the Patel et al. (1986) study of medical experts. In this study, the authors were interested in comparing the recall ability and diagnostic accuracy of experts and novices. The study was modeled after Chase and Simon's (1973) classic study of chess masters in an attempt to replicate their findings in a different domain. The expert participants were 16 family medicine physicians who practiced at a teaching hospital. Novices in this study were 16 second-year medical students.

The participants were presented two clinical cases: one uncommon, but familiar case (acute bacterial endocarditis) and one less familiar case (temporal arteritis). Two forms of each case were made, one typical and one random. A typical case was presented in the order cases are usually presented: patient personal data, then medical history, then physical findings, then lab findings. In the random cases, information was the same, but presented in a random order. So, each participant was given one common and one less familiar case. One of these two cases was presented in a typical order and one of the cases was presented in a random order.

Further, information included in each case was identified as either critical or noncritical, by six subject matter experts. Approximately 9% of the information in the cases was identified as critical.

Participants were given a fixed amount of time to read the text for a case and were then asked to make written protocols of what they had just read without referring back to the text. In addition, participants were asked to make their diagnosis of each case. The diagnoses were given one of three accuracy ratings: accurate, partially accurate, meaning incomplete but accurate, or inaccurate.

As in the Patel et al. (1986) study, protocols were analyzed using propositional analysis such that each of the participant's two protocols were broken down into individual statements. These statements were checked against the original texts and coded as either a recall or inference. Recalls were defined as exact matches of information in the case. An inference was defined as a transformation of any kind made to information in the case. Coughlin and Patel (1987) calculated the number of critical or noncritical propositions recalled or inferred.

An analysis of the protocols revealed a significant response type (recall versus inference) by expertise interaction: experts recalled twice as much information as they inferred while novices showed little difference in the amount of inferences and recalls. In terms of the recall and inference of critical and noncritical information, experts recalled critical information 2 ½ more times than they inferred it, while novices showed no difference in the amount of critical information that was either recalled or inferred. The authors also note that, in general, novice's diagnoses centered around dramatic, noncritical information.

The accuracy of experts and novices in this study was dependent on whether or not the case was structured. For the endocarditis case, experts were significantly more

accurate than novices when the case was normally structured. However, when the case was unstructured, experts and novices were not significantly different in their level of accuracy. These results supported the findings of Chase and Simon (1973) who found that superior memory ability of experts is confined to situations that are familiar to them in their area of expertise.

Overall, this study suggested that medical experts and novices differ in recall ability, particularly the type of information they recall. It appears that experts directly recall more information than novices, and that more of this information is critical to making a decision than not. Analysis of the protocols indicated that making medical diagnoses involves the filtering of critical, or relevant, information from irrelevant information as well as the inferences made from the information provided.

Summary of recall as outcome studies. Across all of the studies reviewed in this section, results were consistent: the recall ability of experts was superior in studies presenting typical or familiar information. However, the situations in which null or weak effects were found involved chess boards, computer code, or medical cases that were presented in a random or atypical way. This suggests that when an expert is presented with a task that is familiar to them, they will outperform novices on recall tasks.

Interestingly, the studies by Patel, Groen, and Fredricksen (1986) and Coughlin and Patel (1987) revealed another potential qualifier to the recall superiority of experts or novices. It appears that relevant and irrelevant information was recalled differently by experts and novices. Specifically, experts were found to recall less irrelevant information (Patel et al., 1986) and directly recall more relevant information (Coughlin & Patel,

1987). In the next section, studies involving performance accuracy as outcomes are reviewed.

Performance Accuracy as Outcomes

Physicists. Simon and Simon (1978) used a verbal protocol method to examine expert versus novice differences in solving physics story problems. The study involved a participant who was classified as an expert in algebra and physics story problems and a participant who was considered to be a novice. The task involved solving 25 problems from a single chapter in a college level physics textbook. The novice made more arithmetic errors while solving the problems than the expert did.

In addition to examining the performance accuracy of the participants, several task processes were compared. First, it was found that, on average, the novice took four times longer to solve a problem than the expert. Also, Simon and Simon (1978) discovered a difference in the general approach that the expert and novice used to solve problems. The expert solved most of the problems by proceeding from the values given in the problem to the unknown values. Simon and Simon called this method forward reasoning. Alternatively, the novice used a backward reasoning approach that involved working from the unknown values in the problem to the given values.

Diagnostic Accuracy as Outcomes

Clinical psychologists. Goldberg (1959) conducted a study that investigated clinical psychologists' ability to diagnose organic brain disorders using the Bender Visual-Motor Gestalt Test. The Bender Visual-Motor Gestalt Test requires the evaluation of a drawing made by a patient. Three groups of participants were included in

this study: four clinical psychologists with 4-9 years of overall experience using the Bender Test, 10 clinical psychology doctoral students with a mean of three years of experience with the Bender Test, and eight hospital secretaries who had no experience using the Bender Test.

The participants were asked to review the test results of 30 patients, 15 with organic brain damage and 15 patients from the psychiatric unit with a nonorganic brain disorder. Participants reviewed the drawing made by each patient and then made their "diagnosis" of the patient into one of two categories, either organic or nonorganic. The percentage of cases accurately diagnosed was calculated. The results of the study revealed no significant differences in the accuracy of clinical psychologists (65%), doctoral students (70%) and secretaries (67%).

Soil judges. Gaeth and Shanteau (1984) studied the change in diagnostic accuracy over time of a group of twelve agricultural students training to be professional soil judges. A common method for evaluating soil involves the estimation of a soil's composition through manual and visual inspection of a soil sample. A training course was developed in which participants received specific training about the relevant and irrelevant information involved with the rating of soil composition.

Participants estimated the percentage of silt, sand, and clay in 16 soil samples before and after receiving an interactive form of training that involved "hands on" practice rating soil content. The participants' estimates of the composition of the soil were significantly more accurate after the training than before. A 12-month follow-up of the former novice participants demonstrated a significant increase in the accuracy of their

follow-up ratings compared to their initial ratings. The authors suggested that the training contributed to the increase in accuracy of the soil judges in this experiment. In fact, the novice participants' follow-up ratings approximated the diagnostic accuracy of an expert soil judge.

Predictive Accuracy as Outcomes

Graduate school admissions. Dawes (1971) compared the predictive accuracy of four graduate school committee members to the predictions made by a computer. The graduate student selection process for the psychology department being studied involved the rating of candidates by an admissions committee composed of faculty members. Upon reviewing the transcripts, test scores, and letters of recommendations for each candidate, the committee members assigned a rating score from 1 to 6. These scores were averaged and ranked to determine who was admitted to the graduate program. Dawes followed the progress of a first-year class of graduate students to evaluate how well the ratings made by the admissions committee predicted student performance after the first year. Students could either pass with distinction, pass, provisionally pass, or be asked to stop at a terminal master's degree.

Dawes compared the predictive ability of the admission committee's ratings of performance to a prediction using a simple, three-criteria regression equation. The regression equation was composed of undergraduate GPA, total GRE score, and a quality index of the student's undergraduate institution. The comparison revealed that the regression equation accounted for 25 times as much of the variance in first year performance as the committee's ratings. In other words, a simple computer equation did

a better job of predicting the performance of graduate students than professors on the admission committee.

Calibration Accuracy as Outcomes

Real estate appraisers. Spence (1996) examined differences in calibration accuracy of novice versus expert real estate appraisers. Calibration was defined as, "the proportion of times a decision makers' ranges include the actual outcome." (Spence, 1996, p. 273). The 67 experts used in this study were certified property appraisers with an average of 15 years in the real estate profession. The 68 novices were students enrolled in a real estate training course. The participants in this study were asked to calculate a market appraisal for a residential property using information from three comparison properties along 17 dimensions. Examples of some of these 17 dimensions were number of bathrooms, square-footage, and type of garage. This study had three independent variables: level of expertise, use/nonuse of a decision aid, and noise/no noise in the calculation. Experimenters gave half of the participants a worksheet that was a blank matrix to be used for writing down calculations (use/nonuse of a decision aid). In the low noise condition, participants were given comparison properties whose overall sales price was predicted by a seven-variable regression model. In the high noise condition, random error was added or subtracted to the sales price of the comparison properties.

Each participant calculated an appraisal value for the property in question and indicated a range around their estimate that they believed included the actual sales price. The range around the estimate was used by researchers to obtain an indicator of

calibration (whether the range included the actual value). An actual sale price was known for the property in question and this price could be used to evaluate the accuracy of the appraisal value.

Overall, experts provided a significantly narrower range than novices did. In addition, the mean of the absolute difference between the experts' appraisal estimate and the actual sales price was significantly smaller than that of novices'. However, in an analysis of whether participants' range included the actual price, experts' ranges specified the actual price significantly less than novices did. In other words, novices were better calibrated than experts, a finding that contradicted the researcher's hypotheses. The narrower range given by experts, coupled with their lower level of calibration compared to novices, suggested that the experts were overconfident in their ratings.

Taken as a whole, this study suggests that although the accuracy of expert judgment may be superior to novices, the calibration of experts may worse than that of novices. Spence speculates that overconfidence, firmly held schemata, or susceptibility to anchoring and adjustment biases may account for the differences in calibration found in this study.

Summary of Task Outcome Differences between Experts and Novices

This section reviewed task outcome differences between experts and novices in recall ability, performance accuracy, diagnostic accuracy, predictive accuracy, and calibration accuracy across a variety of domains. The results of these studies indicated a consistent pattern: experts outperform novices. More specifically, some interesting

findings from several of the studies of recall ability (Coughlin & Patel, 1987; Patel et al., 1986) suggest that experts recall less irrelevant information than novices.

The calibration measure of real estate appraisers (Spence, 1996) was the only measure in which a task outcome for novices was significantly greater than that of an expert. However, it is also important to note that despite being less calibrated, expert real estate appraisers in this study were significantly more accurate than novices.

A few studies in this section found no significant difference between experts and novices on certain measures. For example, the comparison of expert and novice computer programmers revealed no differences in recall ability for unusual board configurations (Chase & Simon, 1973; de Groot, 1965). In addition, there were no significant differences between the diagnoses of brain injuries made by clinical psychologists, doctoral students, and secretaries (Goldberg, 1959). Characteristics about the studies with null effects, as well as the studies outlined in this section in general, provide some ideas regarding variability that may be found in expertise research. A critique of several methodological and theoretical issues relating to the studies in this section is provided next.

First, null effects in studies of expertise may be in part due to the nature of the task in the study. For example, in Goldberg's (1959) study, the diagnoses made by participants were "50/50" decisions that limit the variability of responses that can be made. In other words, some tasks may not be sensitive enough to detect true differences between experts and novices.

Power is another issue that is fairly consistent across studies of expertise. As will be seen in the review of studies throughout the entire introduction, most studies in the expertise literature involve a small sample size. For example, the study of physicists (Simon & Chase, 1973) used a single expert and a singe novice. Patel et al. (1986) used only six novices and six experts in their study of medical experts. Clearly, the small number of subjects in studies of expertise may limit a researcher's ability to find significant statistical differences. However, considering that it is often difficult to identify and recruit experts for participation in experiments, it is no surprise that the sample sizes of these studies tend to be small.

Third, another possible explanation for any variation in expertise results may be the differences in how experts and novices are operationalized across studies. Generally speaking, researchers tried to identify groups based on some indicator of experience. For example, de Groot (1965) used a pre-established ranking system for chess competitions to identify novices and experts. Several studies (Adelson, 1981; Coughlin & Patel, 1987; Patel et al., 1986) used level of education and job title to establish expert and novice groups. The study of graduate school admissions (Dawes, 1971) had no novice comparison group at all. Rather, experts were compared to an analysis performed on a computer. It should also be pointed out that none of the studies discussed in this section used level of knowledge as a way of operationalizing expertise. Recall that a high level of knowledge is a key component in defining expertise. Overall, the variation in the way experts and novices are operationalized complicates the comparison across studies as well as provides a possible alternative explanation for null results.

In addition to task outcome differences between experts and novices presented in this section, several studies also reported some differences in task processes between experts and novices. Adelson (1981) found that experts recalled computer programming code in larger chunks than novices. Simon and Chase (1973) reported that an expert physicist solved problems faster than novices. Further, the expert used a forward reasoning process and the novice used a backward reasoning process. Studies focusing more specifically on task process differences are discussed in the next section.

Task Process Differences between Experts and Novices

The focus of this section turns to "how" one arrives at an outcome, not "what" outcome is reached. A comparison of expert and novice task process differences provides important information above and beyond the existence of any differences in task outcomes. Why? First, consider a situation in which an expert arrives at an outcome that is superior to the outcome of a novice. In this situation, having an understanding of *how* experts arrived at outcome allows you to better understand the differences that exist between experts and novices and provides information regarding how to help novices achieve more "expert-like" outcomes. Alternatively, consider a situation in which a novice and an expert arrive at outcomes of equal quality. By investigating the task process differences of the expert and novice, it may be revealed that the expert arrived at an outcome more efficiently and used only a selection of the information available. Consequently, it would be advantageous to have the expert, rather than the novice, arrive at the outcome.

Articles summarized in this section are organized by the task process domain being investigated. The task process domains included in this section are: (a) quantity and quality of solution alternatives generated, (b) speed of information search, (c) quantity of information searched, (d) repetition of information search, and (e) decision strategies.

Quantity and Quality Of Alternative Solutions as Processes

A study by Butler and Scherer (1997) is the only study that has examined the quality and quantity of expert and novices' solutions to ill-structured problems. One goal of Bulter and Scherer's study was to determine whether differences in expert versus novice decision-maker outcomes, or final choices, was a function of differences in the solution generation process. Specifically, they examined differences in quantity and quality of solutions generated by experts versus novices. In addition to expertise, two other independent variables, presence/absence of a decision aid (objectives) and problem order, were included in the experiment.

Objectives were given to participants either one at a time, as two simultaneous, conflicting objectives, or no objectives were given at all. The order of the two problems were given to the participants was also varied. Experts in this study were graduate students in business with general experience in organizational problem solving. Novices in the study were undergraduate students enrolled in a psychology course. Participants were asked to generate alternatives to a problem regarding sexual harassment involving a female lawyer (Carol's problem) and a problem regarding the compensation of engineers in a market in which engineers were in high demand (Acme's problem).

The dependent variables in this study were quantity and quality of decision alternatives generated. Butler and Scherer utilized Upshaw's (1975) measure of resolving power as an indicator of solution quality. Resolving power was evaluated by trained raters and was defined as, "the degree to which an option resolved the conflicting facets of a problem." (Butler & Scherer, 1997, p. 189). Experts generated significantly more alternatives than novices. In addition, experts generated significantly more resolving alternatives (a measure of resolving power obtained by counting the number of alternatives that resolved the problem) than novices across both problems.

Speed, Quantity, and Repetition of Information Search

The following section provides a review of research primarily focused on comparing experts versus novices in terms of time spent, amount of information searched, and repetitive review of information. These three process-related variables are considered together because they have been simultaneously examined in several studies. Given the large number of studies considered in this section, it is further divided by the domain of expertise investigated.

Pilots. Wiggins and O'Hare's (1995) study of pilots provides an example of an experiment in which the speed, quantity, and repetition of expert and novice information search during a decision task were compared. Participants in the study were 18 novice, 14 intermediate, and 8 expert general aviation pilots. In this study, hours of cross-country flying experience was the criterion for determining experimental groups, two to 100 hours of experience for novices, 101 to 1000 hours of experience for intermediate pilots, and more than 1000 hours for expert pilots.

The experimental task in this study consisted of making a series of weather-related flight decisions. Participants were presented with three cross-country flight scenarios. Information pertaining to each scenario was provided by a computer. An initial computer screen provided the participant with a main menu containing five categories of information: (a) current state of the aircraft, (b) aircraft performance specifications, (c) meteorological information, (d) diagrams of area airports, and (e) topographical maps of the area. Within each of the five categories, specific information could be accessed by pressing the number key corresponding to a given piece of information. A total of 50 pieces of information were available for review during each exercise. A participant could return to the main menu or to any previously viewed piece of information at any time. After reviewing as much information as desired, the participants were asked decide whether they would continue the flight course or return to the departure airport. This study involved the collection of both quantitative information search data and verbal protocols; as each flight decision was made, participants were asked to think aloud and their responses were audiotaped.

Dependent variables in this study were the number of information pieces accessed, the number of information pieces accessed more than once by the participant, the time taken to look at the information, and the time taken to reach a decision after looking at the last piece of information. In addition, the information accessed by each participant was matched to its original category, such as current state of the aircraft and meteorological information, so that the authors could measure how often successive pieces of information were accessed from the same category. In fact, the proportion of

successive information searches from a common category to total information items searched was calculated for each participant. After making their decision as to whether to continue the flight or not, participants were asked to rate the confidence in their decision with a single item on a seven-point scale.

The results of the experiment revealed a significant difference in the amount of information accessed during each scenario. Novices used the most and experts used the least information. In terms of time spent searching information, experts took significantly less total time to search information than novices. In addition, experts reexamined information significantly fewer times than either intermediate or novice pilots.

In an analysis of the search pattern of participants, experts had a significantly lower proportion of successive information sequences made from the same information category as compared to both intermediate and novice pilots. This finding suggests that experts relied less on the categorical information framework provided in the scenarios than novices and used a search strategy of their own.

Given all of the information available to participants, the best decision for them to make was to continue flying toward their intended destination. A comparison of the decisions made by participants revealed that both experts and intermediates choose to continue the flight significantly more often than novices. In other words, the more experienced pilots were significantly more likely to make the correct decision. Regarding the confidence of participants' ratings, novice pilots were significantly less confident in their decisions than either intermediate or expert pilots.

To review the main findings of this study, experts examined less information, in less time, and in a less repetitive manner than novices when presented with a weather-related flight decision. The results of this study support the notion that experts are more structured and efficient decision-makers than novices.

Basketball knowledge. Devine and Kozlowski (1995) studied the decision-making of college students with varying degrees of basketball knowledge. High knowledge and low knowledge groups were determined based on participants' scores on a 40-item test of basketball rules, strategies, and tactics. The experiment presented all participants with both a well-structured and a more ambiguous "end of the game" scenario. The participants were asked to use a computerized information board to select the player that should enter the game. The information board contained eight alternatives, four players already in the game (contextual alternatives) and four players currently on the bench (choice alternatives). All pieces of information on the boards were numerical in nature. The information boards were further manipulated by providing clear player position labels (or not) for the possible alternatives.

The most appropriate response for each scenario was determined a priori by identifying the alternative with the highest rating in the most critical attribute (either the best rebounder or best free-throw shooter) to the scenario given. The accuracy of the decision (selecting the best player) and the number of pieces of information searched were dependent variables in the study.

Participants in the high basketball knowledge group were significantly more accurate in their selections during the well-structured scenario than during selections in

the ambiguous condition. Also, high knowledge participants were significantly more accurate in their decision-making than low-knowledge participants in the well-structured condition. Further, high knowledge participants searched less information than novices in both the well-defined and player-labeled conditions; low knowledge participants searched the same amount of information in either condition.

The results of this study suggest that an expert is more accurate than a novice when given a well-structured problem in the expert's domain of knowledge. Also according to this study, experts engage in a more efficient search of information than novices, given the fewer pieces of information searched by experts.

Sewing machine knowledge. Brucks (1985) studied the information search of high and low knowledge participants in a task involving the hypothetical purchase of a sewing machine. Participants were assigned to high and low knowledge groups based on scores from a test of sewing machine terminology developed by the author. Half of the participants were given a scenario in which the machine they were selecting would be used for complex tasks, while half were instructed that the machine would be used for routine, simple sewing.

A methodology similar to an information board was employed. Participants used a computer interfaced with an experimenter's computer terminal to ask questions about the products. An extensive set of responses to questions had been pre-established so that the experimenter could respond immediately to each participant's questions. Using this methodology, participants had no initial access to attribute categories, such as sewing machine cost and number of stitch settings. Experimenters recorded the number of

information requests made by each participant as well as the appropriateness of the information requested. The set of responses generated ahead of time was coded as either appropriate or inappropriate for both the complex and simple use conditions.

The results of this study indicated that in the complex usage scenario, high knowledge participants examined significantly more information. However, high knowledge participants in the "complex use" group searched information more efficiently, as measured by the search of fewer inappropriate items of information. In addition, participants in the high knowledge group sought information from more attributes than participants with low knowledge. Bruck's study provides further support for differences in information search strategy by experts and novices. In addition, experts searched less inappropriate, in other words, irrelevant information than novices.

House officer admissions. Johnson (1988) studied the decision-making processes of physicians and undergraduates as they reviewed candidates for a medical house officer program. An additional goal of the study was to determine if the inclusion of physicians—in the admissions decision process was more accurate than using other applicant reviewers. Physicians involved in the decision process felt they had expertise regarding the selection process.

This study consisted of two separate sets of data. The first set of data was verbal protocols collected from two physicians and two undergraduates during the admissions process for a medical house officer program as they reviewed six applications. These verbal protocols were broken down into individual thoughts and qualitatively analyzed to examine the process used by experts and novices to make a decision. The average time

each participant took to review a candidate's file and the number of information pieces reviewed were quantitative dependent measures of information search collected in the study as well.

The second set of data included admissions ratings of 156 applicants by 12 physicians and one undergraduate. Both physicians and one of the undergraduates from the verbal protocol portion of the study were included in the rating portion of the study. The applications reviewed typically contained at least 13 pages and 400 pieces of information.

The qualitative analysis of the verbal protocol data revealed differences in the way that experts and novices examined the information about the candidates. For example, experts and novices focused on different parts of the application file. Novices looked at an average of 13% of the information in an applicant's transcript; experts looked at only 3%. Johnson noted that experts seemed to consider an applicant's grades as less important given that medical school grades were awarded on a pass or fail scale. Novices did not seem to be aware of the grading system. In addition, experts focused on only one or two sentences in each letter of recommendation, such as a portion in a dean's letter containing a report of performance in key medical school courses. Experts were able to concentrate their search of information on the most diagnostic portions of an applicant's file.

The analysis of the verbal protocol data revealed that experts took less time than novices to review candidate's files, 7.8 versus 15 minutes per applicant. The greater speed of experts seemed to be due to the significantly fewer pieces of information experts

retrieved compared to novices. Novices retrieved almost twice as much information as experts, 126.5 versus 64.2 pieces. A measurement of decision accuracy was taken by comparing the ratings by the 12 physicians and one undergraduate with a composite ranking of each applicant compiled from rankings by a group of 32 hospitals involved in the National Residency Matching Program. Out of the 13 participants, the novice's ratings explained more variance in matching program ratings than two of the experts.

Looking at the results as a whole, experts not only tended to be more accurate than novices, but were also faster and more efficient in their information search. The qualitative analysis of the verbal protocols provides some interesting information as well. The search pattern of experts suggested that they were engaging in an active process of determining the most relevant information as each applicant was reviewed. A potential explanation for this information search difference is that novices either simply did not possess the background knowledge or have sufficient practice performing the task of admission selections so as to adopt a strategy for using the information available to them.

Auditors. Another study that examined the information search speed of experts and novices was an analysis of archival data, in which a group of auditors were studied throughout the process of gaining expertise in database searches (Salterio, 1996). The participants were all research managers assigned to the central research unit of a single accounting firm. All participants had passed the certified public accounting exam and averaged almost six years in public accounting. However, all participants in the study were new to the central research unit.

The database searches of these accountants over the course of their six-month assignment to the central research unit were analyzed. The database searches involved searches of financial reports of public companies as well as accounting case histories. Searches performed "early" in the assignment (first three weeks) and "late" in the assignment (last three weeks) were compared.

The average amount of time taken to complete each search and the average number of searches made per case were the dependent variables in the study. Compared to the early stage, participants took significantly less time to complete searches in the late stage. In addition, participants searched more information in the late stage of their central research unit assignment.

To summarize, this study both supported and contradicted the finding of the other studies reviewed in this section. Like the other studies, experts searched for information in less time than novices. Unlike the other studies, participants searched more information in the expert phase than in the novice phase. Other studies (Devine & Kozlowski, 1995; Johnson, 1988; Wiggins & O'Hare, 1995) found that experts use less information than novices. However, it should be noted that Salterio's measure of amount of information search is not equivalent to the measures in the other articles in this section. This study's measurement of the amount of information searched was different in that the accountants were accumulating information rather than processing presented information. In the other experiments, it was not necessarily advantageous to search more information. So in other words, the fact that accountants in this study were able to search more information in less time may actually be an indication of enhanced performance on the

part of the experts. On the contrary, if Wiggins and O'Hare (1995) found that pilots were searching more information to make a flight decision, that would be considered as less desirable than being able to make the same decision with less information.

Financial Planners. Earlier in the discussion of the use of scripts by experts, a study of expert versus novice financial planners was described (Hershey et al., 1990). In this study, financial planning experts and novices were presented with a retirement investment decision in which they were to decide whether a hypothetical client should establish an individual retirement account. Participant's level of expertise was established according to scores on a test of knowledge about individual retirement accounts. In addition, experts in the study were all experienced financial planners, while novices were people who usually made their own personal financial decisions but had no formal training in financial planning.

Participants were first asked to determine which pieces of information they would need to make the decision, and they were provided with all requested information. Participants were tape-recorded as they "thought aloud" while making a decision. Once the decision process had started, participants could also ask for additional information.

The transcripts of the verbal protocol were translated into a flow diagram, called a problem solving process map, to aid in analysis. The decision processes of the participants were evaluated along several dimensions: time taken to complete the task, the number of steps involved, number of information pieces reconsidered, and number of additional information pieces requested.

Analysis of the verbal protocols in this study revealed several differences in expert and novice decision-making. Experts completed the decision-making task significantly faster than novices, nine versus 21 minutes on average. Experts also made their decisions in significantly fewer steps than novices, 5.7 versus 13.7 steps on average. In addition, experts were more efficient in their information search because they were much less likely than novices to consider information more than once. In addition, novices asked for significantly more pieces of additional information, 19 versus four total additional pieces of information requested.

In summary, this study provides evidence that experts are faster than novices at making decisions. In addition, experts make decisions more efficiently by using fewer steps, reconsidering less information, and requesting less additional information than novices.

Real estate appraisers. Spence and Brucks (1997) studied expert and novice real estate appraisers. The data analyzed in this article was the same data used in a previously described study (Spence, 1996). Participants were asked to determine the market value of a property given information about the property and three similar houses along 17 dimensions, including number of bathrooms, square-footage, and type of garage.

This study had four independent variables, level of expertise, use/nonuse of a decision aid, diagnosticity of the information, and presence or absence of noise in the calculation. The independent variables were defined as follows. Experts used in this study were state-certified property appraisers, while novices were individuals who had begun coursework to become a real estate professional. The decision aid manipulation

involved half of the participants being given a worksheet to be used for writing down calculations and half of the participants being given a blank sheet of paper. The worksheet was a decision aid because it provided cues and calculation instructions for how to combine information to determine an appraisal value. A low level of noise was defined as an appraisal calculation that could be predicted using a regression model that included the price of the house and the three similar houses. In the high noise condition, random error was added or subtracted to the value of various components of the comparison properties.

The level of diagnositicity refers to the extent to which the values on a dimension provide a meaningful comparison of the three reference properties. Three of the property dimensions were low in diagnosticity. In other words, there was no difference between the values of the reference properties and the property being appraised on those dimensions. Seven of the dimensions were high in diagnosticity (dimension values differed across properties). Values for the other seven dimensions were only slightly different, comparing the reference properties to the property being appraised.

Several dependent measures were used in this study: the appraisal value, the number of pieces of comparison property information used, the time taken to complete the calculation, and a rating of how influential each dimension was in making a decision. Participants used a seven-point scale to reflect the degree of influence each dimension had on making the final decision (1 = not influential, 7 = extremely influential).

Results of the study indicated that without the decision aid, experts took less time to perform the calculation than novices. However, experts took more time to complete

the task with a decision aid than without a decision aid. Spence and Brucks suggest that the decision aid increased the processing effort of experts because it focused their attention on information not useful for making the appraisal. In addition, across all conditions experts used less overall information than novices did.

In a comparison of the "degree of influence" ratings of experts and novices, experts rated significantly fewer attributes as influential. Also, experts rated low diagnostic dimensions as significantly less influential than did novices. These findings suggest that experts are better at filtering out irrelevant information than novices. Further, experts were more accurate in their calculation of an appraisal value and their accuracy was not negatively affected by the noise manipulation.

Several conclusions about expert versus novice decision-making can be drawn from this study. First, experts are more efficient than novices when processing information, as demonstrated by experts' speed at making decision when not given a decision aid. However, when a component of the decision-making task is included that is not necessarily helpful for an expert, such as decision aids, the information search behavior of experts is disrupted. In other words, decision aids do not provide the same benefit to both experts and novices. Finally, differences in the "degree of influence" ratings suggest that experts are better at filtering out irrelevant information than novices.

Summary of Speed, Quantity, and Repetition of Information Search as Processes Studies

The current section reviewed seven studies of expert and novice task process differences that primarily measured some combination of the following task processes: (a) speed of information search, (b) quantity of information search, (c) and repetition of

information search. For each of these three task-processing domains, themes can be identified across research findings. First, concerning speed of information search, all studies that measured this domain found that experts were significantly faster than novices.

Second, in terms of quantity of information search, results generally indicated that experts search significantly less information than novices (Johnson, 1988; Spence & Brucks, 1997; Wiggins & O'Hare, 1995). However, in the studies involving sewing machine knowledge (Brucks, 1985) and accountants (Salterio, 1996), experts searched more information than novices. As described earlier, Salterio's (1996) findings may be due to the fact that the experimental task had a different focus than the other studies; it was particularly advantageous for participants to search more information. Third, the studies that investigated repetition of information search (Hershey et al., 1990; Wiggins & O'Hare, 1995) found that novices repetitively view information significantly more often than experts.

In addition, several of these seven studies presented findings regarding the type of information searched by experts versus novices. Brucks (1985) found that experts examined fewer pieces of inappropriate information than novices. In Johnson's (1988) study of house officer admissions decisions, it was reported that the experts (physicians) focused on a limited amount of the information presented. Further, the information focused on by experts was considered by them to be the most diagnostic information. In the Hershey et al. (1990) study of financial planners, experts searched less inappropriate

information. Together, these findings suggest that experts and novices differ in the way in which they use or process relevant and irrelevant information.

Next, a fifth and final type of task process difference, decision strategy, will be discussed. The six studies described in this section focus on various stages throughout the decision-making process. Given the large number of studies considered in this section, it is further divided by the domain of expertise investigated. Following this section, a summary of all task performance process studies discussed will be made.

Decision Strategies as Processes

Physicists. Chi, Feltovich, and Glaser (1981) studied expert and novice differences in decision-making at the problem representation stage of the decision-making process. Problem representation was defined by Chi and colleagues as, "a cognitive structure corresponding to a problem, constructed by a solver on the basis of his domain-related knowledge and its organization." (p.122). In the problem representation stage, a person is trying to understand the problem. The authors considered the categorization of problems as an indication of problem representation and hypothesized that expert and novice physicists categorize physics problems differently.

Experts in this study were eight advanced doctoral students in physics; novices were eight undergraduate physics students who had completed a course in mechanics. The experimental task involved participants categorizing 24 problems taken from a physics textbook. The problems were presented on index cards and participants were asked to sort these problems into stacks based on the similarity of the solution. In

addition, participants were asked to verbally report their reasoning throughout the sorting process. The verbal reports were audiotaped and transcribed.

An analysis of the verbal reports revealed that experts and novices used qualitatively different categorization schemes with almost no overlap. Specifically, only five of the 20 categories created were used by both an expert and a novice. Content analysis was performed on four of the 24 problems, and this analysis revealed differences in the categorization approach. Novices grouped problems together based on surface characteristics of the problem, defined as literal objects or terms mentioned in the problem. On the other hand, experts categorized problems based on major physics principles, such as the law of conservation of energy or Newton's second law.

Chi and colleagues (1981) conducted another experiment involving expert and novice physicists. Participants were presented 20 problems from a physics textbook and were asked to talk through how they would solve each problem. The experts in the study were two physics professors who taught courses in mechanics and the novices were two undergraduate students who had just completed a mechanics course and received an A. The verbal protocols of the participants were audiotaped, transcribed, and analyzed to determine the basic approach taken to solve each problem. The authors defined the basic approach as the major principle used to solve the problem.

As in Chi and colleagues first experiment, experts and novices used different approaches. In fact, no overlap existed between what experts and novices identified as key features of the problem. Once again, experts used major physics principles to guide their selection of a basic approach for solving the problems. Experts were able to

incorporate theories and concepts of physics that were not directly stated or implied in the problem. The novices in the study used objects or concepts literally stated in the problem to come up with an approach for solving the problem. For example, if the problem involved a calculation relating to a spring, novices characterized the problem as a spring problem, while experts classified the problem based on the underlying principle involved in performing the calculation.

The results of these two studies of physicists suggest an important difference in how experts and novices make decisions. Experts and novices created problem representations in different ways using different types of information.

Recall from the earlier discussion of schemata (Hershey et al., 1990) that experts are more likely than novices to use schemata to guide their decisions. The results of this experiment suggested that experts are using a pre-existing schema, as they use major physics principles to both categorize and solve physics problems. Apparently, experts are using this schema to guide them through the process of evaluating information given to them. If novices are utilizing a schema to make problem representations, novices seem confined to using only the information directly given in a problem. Given that the most important part of a physics problem is the underlying theory, not the object under consideration, these experiments provide evidence that experts may understand the problems better. While these studies did not investigate the information that the participants would have actually used to solve the problems, the differences in categorization and strategy suggest that information would be used differently to solve the problem.

Loan officers. Scherer, Johanson, and Brown's (1999) study of loan officers revealed decision strategy differences between experts and novices. Specifically, the researchers were interested in whether or not participants engaged in irrational escalation of commitment while making decisions within their domain of expert knowledge. Scherer and colleagues conducted two experiments; one with experts, and a replication study involving novices.

In Experiment 1, the participants were male loan officers who were given four scenarios involving businesses that were in financial trouble and in need of an additional loan from the bank to continue business. For all of the scenarios, the expected mean return for the bank was held constant. However, the scenarios were manipulated so that they varied along two independent variables: personal responsibility and ambiguity of the decision outcome. Personal responsibility (high and low) was varied such that participants were told that they either were or were not the person responsible for making the initial loan to the business. In the unambiguous condition, participants were given the percentage chance of success if the loan was provided. In the ambiguous condition, no information about percentage chance of success was provided. Each participant decided whether or not they would approve a second loan for four scenarios. The participants responded to a scenario containing each of the possible combinations of the responsibility and ambiguity conditions. For scenarios containing the ambiguous condition, participants were also asked to provide their estimate of the percentage chance of success for the business.

An examination of responses to the ambiguous scenarios indicated that significantly more officers approved the loan in the high responsibility condition than the low responsibility condition. When responding to the unambiguous scenario, the approval rate was not significantly different according to responsibility. In addition, loan officers gave significantly higher probability ratings when responding to the ambiguous/high responsibility scenario versus the ambiguous/low responsibility scenario. The results of this study indicated that escalation of commitment to approve the loan was more likely to occur in situations that are ambiguous and involve high personal responsibility. Further, responses made by the loan officers shed light on the ability of expert decision-makers in a familiar domain. Specifically, in unambiguous scenarios, officers showed no escalation of commitment. When the scenario was structured to be ambiguous, the escalation of commitment occurred, particularly when participants were in the high personal responsibility condition. Scherer and colleagues offered overconfidence as a possible mechanism for irrational escalation of commitment.

The study involving loan officers was replicated using undergraduate students as participants. Students were considered to be novices in the domain of making loan decisions and could thus provide a comparison of expert and novice decision behavior on this task. Specifically, the authors hypothesized that given the students' lack of knowledge in the banking profession, the ambiguity manipulation would have no effect and that students would demonstrate an escalation of commitment across both ambiguity conditions. Compared to the findings in the experiment with loan officers, there was no significant difference between high responsibility and low responsibility groups in loan

approval for ambiguous scenarios. Overall, novices escalated commitment more frequently than experts. However, the pattern of novices' responses indicated that irrational escalation of commitment was not an explanation for behavior, given that the level of responsibility had no effect on decisions. The factor appearing to account for the responses of the novices was a surface feature of the problem, the probability of loan success. Rather than attend to the ambiguity of the scenario, novices attended solely on a surface feature of the scenario to make a decision, namely the chance that second loan would result in a successful outcome for the lender.

In summary, the results of this study suggest that novices attend to the surface features of the problem while experts attend to deeper aspects of the problem. This was evidenced in the fact that experts were clearly affected by characteristics of the problem, suggesting that experts pay attention to, and are influenced by, pertinent pieces of information relating to a decision. The fact that experts attended to both the ambiguity and responsibility manipulations, while novices did not, supports the notion that differences exist between how experts and novices process information used to make a decision.

Nurses. A study conducted by Corcoran (1986) compared the initial decision approach, overall decision approach, and decision quality of expert and novice hospice nurses. In this study, six expert and five novice hospice nurses were asked to develop drug administration plans for patients described in a written case study. Experts were nurses with at least 18 months experience in hospice nursing and who met at least one of the following criteria, (a) authored a published article relating to hospice nursing and/or

pain control, (b) made at least one presentation about hospice nursing and/or pain management to a professional group, (c) offered continuing education programs on hospice nursing and/or pain control, or (d) were identified as an expert by at least five other hospice nurses. Novices were registered nurses with at least six months experience as a hospice nurse.

Each participant was asked to develop a written drug administration plan for three case studies. The cases were written by the investigator and a hospice nursing expert. The level of complexity of each case was manipulated so that each participant received a case of low, medium, and high complexity. Case complexity was determined by the patient's number of pain-related problems, the relatedness of the pain problems, and how well existing pain protocols could be used in the case. Participants were tape-recorded as they "thought aloud" during the development of the plans.

The consultant who cowrote the cases developed a recommended course of action for each case and this course of action was used to create a four-point quality rating scale to be used to compare plans generated by participants. The scale ranged from a one, "consistent with the consultant's plan for the case", to four, "erroneous". In addition to the quality rating, the initial approach taken by participants when formulating each plan was coded as either broad or narrow. An initial approach was labeled broad if the participant commented on two or more pain-related problems immediately after reading the case description but before making any decisions.

A third dependent measure in the study was a rating of participant's overall decision approach as either opportunistic or systematic. An approach coded as

opportunistic was multidirectional and jumped around from one problem to another. In contrast, a systematic approach was defined as one that proceeds in a sequential, orderly fashion. Two trained raters were used to provide ratings of quality, initial approach, and overall approach.

The results of the study indicated that neither novices nor experts significantly varied their initial approaches across cases of varying complexity. Most experts used a broad initial approach, but no initial approach pattern was evident for novices. Those experts who used a broad approach for low complexity cases tended to use a broad approach for medium and high complexity cases as well. However, experts significantly varied their overall approach according to case complexity, while novices did not. Most experts used an opportunistic approach for the complex cases and a systematic approach for the least complex case. On the other hand, novices used opportunistic approaches across all cases.

Experts did not develop significantly higher quality plans than novices; however, when looking at decision quality based on case complexity, an interesting pattern emerged. Looking at experts and novices separately, novices developed higher quality plans for the least complex case while experts developed the highest quality solutions to the most complex case. Further, there was no significant relationship between overall approaches and the quality of plans.

Unlike previously discussed experiments with physicists, Corcoran's study attempted to look at the solution strategies of expert and novices throughout an entire decision process. Several of the expert versus novice process differences found in this

study are of particular interest. The first of these findings relates to those reported by Chi and colleagues (1981), namely, that experts changed their overall approach according to case complexity. This finding suggests that differences may exist between how experts and novices form a representation of a problem, and consequently, influences the choice of an overall strategy. Novices' use of an opportunistic approach regardless of case complexity suggests that they lack a framework from which to base the information used to make a decision. Alternatively, experts may have been using a systematic approach for the least complex cases because these problems were familiar and previously encountered in their experiences as a nurse. As the cases increased in complexity, the experts may have needed to look at different parts of the problem as a way of developing a decision strategy. Despite the use of an opportunistic approach, experts made their highest quality decisions with the most complex cases, suggesting that experts are able to integrate the information provided and their own background knowledge. Overall, this study provides additional evidence that differences exist in the strategies experts and novices use while making decisions.

Life insurance policy selection. Kuusela and Spence (1998) conducted a study comparing expert and novice decision-making strategy. The experimental task involved the selection of a life insurance policy. Participants were 54 Finnish business students and business people. Three groups of subjects, novice, moderate, and expert, were determined based on scores on a 25-item test involving insurance terminology. The test was given after the completion of the main tasks of the experiment.

Participants were asked to select one life insurance policy from seven alternatives. The life insurance options were displayed on a 22-attribute by seven-alternative information board. Some of the attributes included were assurance payable at death, market share, and company solvency. The participants were asked to think aloud as they reviewed the information about the insurance policies on the information board; participant comments were tape-recorded and coded for later analysis.

The think-aloud transcripts were broken down into individual statements and each statement was grouped into one of five categories. The categories reflected different steps, or "task statements," in the decision-making process: (a) searching for information, (b) making pairwise and/or multiple comparisons between options, (c) criteria used for eliminating one or more attribute, (d) criteria used to select a policy, and (e) misunderstanding of the information presented.

The frequency that each of the three groups of participants engaged in the five types of statements was compared. Kuusela and Spence used the frequency of using elimination criteria as a rough measure of a noncompensatory, or contingent, search strategy. When engaging in a noncompensatory search strategy, a decision-maker is not examining all pieces of available information. Rather, the decision-maker may simplify the decision process by establishing a criterion for one or more of the decision attributes and eliminating all alternatives that do not meet these criteria (Payne, 1976). Alternatively, Kuusela and Spence classified a compensatory search strategy as an instance in a verbal protocol when a participant explicitly compared two or more insurance options. Within the decision making literature, a compensatory search strategy

is defined as one in which the evaluation of an alternative is based on a combination of ratings of all the attributes for a given alternative (Payne, 1976). The use of a compensatory search strategy is one in which the value of attributes rated as high for a given alternative can be traded off for attributes of the same alternative that are rated low. A compensatory search of information is more effortful than a noncompensatory search, given that it involves an examination of all available information to arrive at a rating for each alternative.

Within the choice criteria category, statements were also subdivided and classified in terms of whether the option was chosen because of one of seven specific criteria, information not stated in the problem, a misunderstanding of the information, or a compensatory decision rule.

There was no statistically significant difference in the number of information search statements made by experts, moderates, and novices; however, experts made more information statements than either moderates or novices. In addition, no significant differences were found among groups in the number of elimination criteria statements made. In fact, an average of less than two elimination criteria statements per participant were made. In other words, noncompensatory search strategies were seldom used, regardless of expertise level.

It is interesting to note the different reasons that experts, moderates, and novices gave for eliminating alternatives. Surface characteristics of the problem, such as an insurance company's name or brand image was a reason for 81% of novice elimination statements, while the eliminating criteria for moderates and experts involved more

substantive aspects of the company itself such as the operating costs of the firm. This finding parallels the deep versus surface problem representation distinction made by Chi and colleagues (1981). Kuusela and Spence also noted that when experts used elimination criteria, they tended to use only one criterion such that all alternatives not meeting the criterion were eliminated. Tversky (1972) called this type of noncompensatory search strategy an elimination-by-aspects (EBA) strategy.

Also, the average number of times that misunderstanding statements were made by experts (11.2), moderates (12.7), and novices (12.6) was not significantly different. However, the sheer number of misunderstanding statements made by experts indicated that portions of the information provided were unclear. The authors contend that participant misunderstanding contributes to a reduction in the use of noncompensatory search behavior.

Experts, moderates, and novices showed significant differences in the frequency of two of the five statement types: pairwise and/or multiple comparisons, and choice criteria. Experts were documented as making significantly more pairwise and/or multiple comparisons than either moderates or novices, suggesting that experts were using more compensatory search strategies than the other two groups. This finding was supported by the fact that experts also made significantly more choice criteria statements than either moderates or novices. The authors subdivided the choice criteria statements made by participants based on the specific criteria used in these statements. Fifty percent of the choice criteria statements made by experts were classified as compensatory decision rules, compared to 36 % for moderates and 27% for novices. Further analysis of novice

responses indicated that the company or brand image (24.3%) and information not stated on the information board (27%), such as having a friend that worked for one of the insurance companies, accounted a substantial proportion of the criteria statements made by novices. In comparison, none of the expert's choice criteria statements involved information not provided and only 5% of the expert's choice criteria came from company or brand image.

The results of this study provide evidence that experts and novices use qualitatively different information search strategies when making decisions and use simplifying strategies at least some of the time. Although noncompensatory strategies were seldom used, when experts used noncompensatory strategies, they focused on a single attribute. In establishing choice and elimination criteria, novices tended to rely on superficial information while experts used more substantial, complex information given in the problem. The finding supports the surface versus deep representation distinction made by Chi and colleagues (1982) in that experts are using more critical or fundamental information than novices when making a decision.

As a final note regarding the Kuusela and Spence (1998) study, it is curious that they used data from the verbal protocols to distinguish compensatory from noncompensatory search strategy. Given that they used a computerized information board, the search strategy of the participants could have been determined statistically by analyzing the sequence in which information was searched on the information board (Payne, 1976).

Auditors. Ettenson, Shanteau, and Krogstad (1987) investigated the decision strategy used by expert and novice auditors in terms of the type of information used to make a decision. The study consisted of three groups of participants. Audit partners from "Big-Eight" accounting firms with at least eight years of professional experience constituted the expert group. The second group was composed of moderately experienced participants who were audit seniors from "Big-Eight" accounting firms with at least two years of professional experience. A third group of participants was composed of upper-level accounting students who had taken one, but no more than two, courses in auditing and had no professional auditing experience.

The task in this experiment required participants to provide a rating of materiality for hypothetical auditing cases (Ettenson et al., 1987). Materiality is a judgment made by auditors when determining the credibility of a financial statement. Within the auditing profession it is widely agreed that a single issue, the effect of net income, is the most relevant factor in determining materiality. Hypothetical auditing cases were constructed so that each contained eight pieces of information, or cues. The cues related to previous audits and economic conditions; one cue included was the effect of net income. Sixteen cases were constructed by establishing two possible numeric values for each of the eight cues and then combining all possible combinations of cues. Participants read each case and made a rating of materiality by marking a line on a scale ranging from clearly immaterial to clearly material.

An individual analysis of variance for each participant and the percent of variance accounted for by each cue, an indicator of cue importance, were calculated. There were

no significant differences across groups in the number of significant cues that contributed to variance; approximately three cues were significant for all three groups. However, the effect of the net income cue was significant for all participants in the partner and senior group, yet the effect of net income was not a significant cue for three of the 11 student participants. For the partner group, 76% of the variance in materiality rating was accounted for by the effect of net income cue. For the senior group, 65% of the variance in materiality rating was accounted for by the effect of net income cue. Alternatively, no single cue accounted for a majority of the variance in materiality rating in the student group. In general, the variance for the participants in the student group was spread across several cues.

To summarize the findings of this study, experts and novices all used multiple cues to reach a judgment; however, experts focused primarily on the most important, or relevant, cue available.

Summary of Decision Strategies as Processes Studies

In this section, six studies involving the search strategy of expert and novice decision makers have been summarized. Overall, the results of these studies indicated that experts and novices engaged in different decision-making strategies. At the problem representation stage, novices use surface and experts use more complex, theoretical aspects of the problem (Chi, Feltovich, and Glaser, 1982). Scherer et al. (1999) and Kuusela and Spence (1998) also found that novices attend to surface aspects of a problem and experts attend to deeper aspects of the problem. Experts alter their overall decision strategy based on problem complexity, while novices do not (Corcoran, 1986). In

addition, experts and novices both use simplified search strategies, yet rely on different types of information in formulating criteria (Kuusela and Spence, 1998). Also, expert auditors more frequently used information that is most relevant to the decision being made (Ettenson et al., 1987).

Summary of Task Process Differences between Experts and Novices

In this section, studies concerning task process differences between experts and novices were reviewed from the following five task process domains: (a) quantity and quality of solution alternatives generated, (b) speed of information search, (c) quantity of information searched, (d) repetition of information search, and (e) decision strategies. Overall, the results of these studies indicate that task process differences exist between experts and novices.

To be more specific, experts generate more solutions and higher quality solutions than novices (Butler & Scherer, 1997). In addition, experts search information faster (Hershey et al., 1990; Johnson, 1988; Salterio, 1996; Wiggins & O'Hare, 1995), look at less information (Johnson, 1988; Spence & Brucks, 1997; Wiggins & O'Hare, 1995), and search information less repetitively than novices (Hershey et al., 1990; Wiggins & O'Hare, 1995).

In addition, a number of decision strategy differences have been found between experts and novices. Recall from the task outcome section that experts group information into larger chunks (Adelson, 1981) and use forward versus backward reasoning when problem solving (Simon & Chase, 1973). Studies outlined in the previous section indicate that experts represent problems using deep information and novices use surface

information (Chi et al., 1981; Scherer et al., 1999). A study of nurses found that experts alter their overall decision strategy based on problem complexity and novices do not (Corcoran, 1986). When making a decision between life insurance policies, experts and novices both use simplified search strategies, yet experts and novices rely on different types of information in formulating criteria (Kuusela and Spence, 1998). For example, novices relied more on information about brand image than experts. Finally, in a study of auditors, experts focused on cues most relevant to making a decision and novices did not (Ettenson et al., 1987).

A consideration of the articles summarized in this section reveals that task process differences have been found across a variety of domains, from sewing machine knowledge to piloting a plane. As with the previous discussion of studies focusing on task outcome differences between experts and novices, a limitation of the findings of task process studies is that expertise was conceptualized in many different ways. For example, some studies used professional certification (Spence & Brucks, 1997) or job title (Johnson, 1988) as indicators of expertise. The study involving pilots (Wiggins & O'Hare, 1995) used hours of flight experience as a measure of expertise. In comparison, expert hospice nurses were identified using a combination of both years of work experience and professional accomplishments such as publishing a professional article (Corcoran, 1986).

Studies in the domains of basketball knowledge (Devine & Kozlowski, 1995), sewing machine knowledge (Brucks, 1985), life insurance policy selection (Kuusela & Spence, 1998), and financial planning (Hershey et al., 1990) used a knowledge test to

identify expert and novice participants. For two of these studies, the knowledge test was the only indicator of the level of expertise. However, in the case of the financial planning study (Hershey et al., 1990) and the study of life insurance policy selection (Kuusela & Spence, 1998), participants were initially identified according to experience in the domain, then took the knowledge test as a verification of their level of expertise.

The differences in how expertise was operationalized across studies makes it difficult to compare findings. In addition, it seems that numerous studies of expertise have not incorporated the full understanding of what constitutes an expert into their method for identifying participants. For example, some studies have tried to identify experts based on amount of experience or credentials, others have used measures of knowledge level, but few have tried to identify experts using both knowledge and experience or credentials. According to the existing definitions of expertise, the best identification of experts and novices may result from using indicators of both experience or credentials and knowledge.

The focus of this proposal now turns to the current investigation. The preceding literature review compared differences between experts and novices in both task outcome and task process domains. Following from the results of these studies, the current investigation has been formulated. The next section introduces the current investigation, including its theoretical and empirical rational. The section concludes with research hypotheses for the current investigation.

This Investigation

Overall Summary of Task Outcome and Process Differences between Experts and Novices

Before describing any specifics relating to the current investigation, it is useful to review the major findings presented in the preceding literature review. First, in studies comparing expert and novice task outcomes, experts were superior to novices in recall ability, performance accuracy, diagnostic accuracy, and predictive accuracy. Novices outperformed experts in only a single case, a measure of calibration, yet experts in the same study were still superior to novices in overall accuracy in appraising the value of a property (Spence, 1996).

Expert and novice differences have been documented across a variety of task process domains. Experts generate more, and higher quality, solutions to problems than novices (Butler & Scherer, 1997). Experts are more efficient in their search of information: experts search information faster (Hershey et al., 1990; Johnson, 1988; Salterio, 1996; Wiggins & O'Hare, 1995), search less information (Johnson, 1988; Spence & Brucks, 1997; Wiggins & O'Hare, 1995), and search less repetitively (Hershey et al., 1990; Wiggins & O'Hare, 1995) than novices.

Other task process differences have been found between experts and novices in terms of strategies used to make a decision. In recall tasks performed by computer programmers, experts chunk information into larger groups than novices (Adelson, 1981). An expert physicist uses a forward strategy to solve problems, proceeding from the known aspects of problem to the unknown aspects. The novice in that study used a

backward strategy by beginning with problem unknowns (Simon & Simon, 1978). Expert loan officers, expert physicists, and people with high levels of knowledge about life insurance represented problems using deep information such as theoretical principles; novices in these studies used surface information such as information presented in a problem (Chi et al., 1981; Kuusela & Spence, 1998; Scherer et al., 1999). Experts also appear to alter their overall decision strategy based on the complexity of the task and novices do not (Corcoran, 1986). In the study of life insurance policy selection, experts and novices both used simplified search strategies, however both groups relied on different types of information in formulating criteria (Kuusela and Spence, 1998).

Across the findings for both task outcome and task process difference studies of experts and novices, an additional interesting theme can be identified. Expert and novice differences have been found in the recall, search, and identification of relevant and irrelevant information. Recall from Patel, Groen, and Fredricksen's (1986) study of physicians and medical students that novices recalled nearly twice as many irrelevant pieces of information as experts. Similarly, Coughlin and Patel (1987) found that experts (physicians) directly recalled relevant information 2 ½ more times than they inferred it, yet novices showed no difference in the amount of relevant information that was either recalled or inferred. These two studies suggested that when presented with information, experts have the capacity to recall more of the relevant information than novices.

In another task outcome study, soil judges significantly increased their diagnostic accuracy as revealed from scores when the judges were novices compared to scores a year later (Gaeth & Shanteau, 1984). In between the two test periods, the soil judges

were given specific training regarding relevant and irrelevant factors in judging the composition of soil. This finding lends support to the idea that a person learning to discriminate relevant from irrelevant information may lead to an improvement in task outcomes.

Several of the studies discussed in the "speed, quantity, and repetition of information search as processes" section present differences between how experts and novices search relevant and irrelevant information. Brucks' (1985) study of participants with high and low levels of knowledge about sewing machines found that high knowledge participants examined fewer pieces of inappropriate information than low knowledge participants. Similarly, in the Hershey et al. (1990) study of financial planners, experts searched less inappropriate information. In the Spence and Brucks (1997) experiment involving real estate appraisal, experts rated low diagnostic dimensions, which were dimensions not relevant to calculation of an appraisal value, as less influential than did novices. Johnson's (1988) study of house officer admissions decisions reported that the experts (physicians) focused on a limited amount of the information presented. Further, the information that experts focused on in this study was considered by them to be only the most diagnostic information.

Finally, one of the studies in the "decision strategies as processes" section of the literature review reported a difference between the type of information used by auditors to make a decision. Ettenson et al. (1987) found that experts focused on the piece of information that was most relevant to making the decision, and novices focused on a variety of less relevant pieces of information.

The above mentioned task outcome and task process studies indicated that expert and novice differences in the recall, search, and identification of relevant and irrelevant information are important factors in understanding more about expertise. To that end, one of the leading researchers in the field of expertise has suggested a theoretical model that makes such a claim.

Shanteau (1992) has theorized that the ability to discriminate between relevant and irrelevant information is what primarily differentiates experts from novices. This claim comes from a reexamination of data from several of his previous studies of expert and novice decision-makers, in domains ranging from medicine to livestock judging. When these studies were originally analyzed, the amount of information used by experts and novices was the dependent measure. Shanteau analyzed the results again in order to determine the proportion of relevant and irrelevant information used by experts and novices. Irrelevant information was defined as information not diagnostic for the decision under consideration. Shanteau concluded that novices use qualitatively different, namely less relevant, information than experts.

Following the above-mentioned studies and Shanteau's theoretical model, in the current investigation I have explored the notion that the ability to distinguish relevant from irrelevant information is a defining characteristic of experts. Previous research indicates that experts are able to recall, search, and identify relevant from irrelevant information more successfully than novices, but more research is need in different domains and contexts to further support Shanteau's theoretical claim.

Important Distinctions Regarding Expertise and Knowledge

Before describing the independent and dependent variables used in the current investigation, it is important to make a few additional comments about the operationalization of expertise, perhaps the most complicated issue related to expertise research. Recall from earlier in the literature review that numerous approaches have been used to identify expert and novice participants for research. Given the differences that exist in how expertise has been defined, it is critical that new expertise research should be clear about the operationalization of experts and novices. Also recall from the discussion of expertise definitions that a high level of performance and a high level of knowledge are two common themes found across the definitions of expertise.

Generally speaking, researchers have used one of two approaches to select expert and novice participants: (a) professional credentials, education level, or experience, or (b) level of domain knowledge. Examples of studies using the first approach are Spence and Bruck's (1997) study of real estate appraisers selected using professional certification, Simon and Simon's (1973) study of physicists selected using level of education, and Wiggins and O'Hare's (1995) study of pilots that selected participants based on hours of flight experience. Four previous expertise studies, in the following domains, have used a knowledge test as a way of selecting participants: basketball knowledge (Devine & Kozlowski, 1995), sewing machine knowledge (Brucks, 1985), life insurance policy selection (Kuusela & Spence, 1998), and financial planning (Hershey et al., 1990). The combined use of credentials/education/experience and knowledge level to identify expert and novice participants has been rare. In fact, only two studies (Hershey et al., 1990;

Kuusela & Spence, 1998) have used a combination of professional credentials, educational level, or experience and a knowledge test.

If researchers generally agree that experts possess higher levels of knowledge than novices, what *kind* of knowledge are they talking about? Earlier in the discussion of definitions of expertise, a distinction was made between declarative and procedure knowledge (Anderson, 1982). Declarative knowledge is factual knowledge. Procedural knowledge involves the process of how things should be done. Wagner and Sternberg (1985) use the term tacit knowledge in place of procedural knowledge and consider tacit knowledge to be the indicator of a person's practical intelligence, or street smarts. These researchers have gathered some empirical evidence regarding the relationship between tacit knowledge and task performance of experts.

Wagner and Sternberg (1985) created a series of tacit knowledge measures that involve domain-specific situations in which a participant reads the scenario and rates the importance of engaging in a list of actions related to the situation. For example, in the domain of business management, a participant may be given a scenario about the condition of their employment in a particular company and then asked about how important a number of actions may be for rapid promotion in the company.

Wagner and Sternberg (1985) conducted several experiments in which the participants were meant to represent experts in their respective fields. First, academic psychologists from various universities were given a tacit knowledge test. The scores on the tacit knowledge test were correlated with measures of job performance: (a) number of publications, (b) number of conferences attended, and (c) prestige of school where

employed. There was a significant positive correlation between these measures of job performance and scores on the tacit knowledge test.

Second, in a replication of the above experiment, business managers from a variety of companies were given a tacit knowledge test and the scores from this test were correlated with measures of job performance, level of company in the Fortune 500 ratings, and salary. As in the first experiment, there was a significant positive correlation between these measures of job performance and scores on the tacit knowledge test. The findings from these two experiments suggest that tacit, or procedural, knowledge is an important component in the successful task performance of experts.

Wagner and Sternberg (1990) conducted another study to test the relationship between task performance and tacit knowledge. Participants were experienced managers and business executives. Participants were given a tacit knowledge test similar to the tests previously used by Wagner and Sternberg (1985) and a battery of other tests: (a) the Shipley IQ test, (b) the Myers-Briggs Type Indicator, (c) the Fundamental Interpersonal Relations Orientation-Behavior scale, (d) the Hidden Figures Test of field independence, (e) the Kirton Adaptation Innovation Inventory of preference for innovation, and the (f) Managerial Job Satisfaction Questionnaire. Scores from a managerial assessment center activity served as the dependent variable for this study. In a series of regression analyses that were performed, tacit knowledge was the single best predictor of scores on the assessment center activity. In addition, when tacit knowledge was entered as the last predictor, it accounted for a significant additional amount of variance (17%) in the scores

on the assessment center. This study provides additional evidence that tacit knowledge is related to successful task performance of experts.

The results from the above mentioned studies suggest that tacit or procedural knowledge is an important component of an expert's high level of knowledge. Curiously, only one study (Devine & Kozlowski, 1995) has used a knowledge test including both declarative and procedural knowledge questions to identify novices and experts. In this study, participants were given a test of basketball knowledge that included questions relating to basketball rules, strategies, and tactics (Devine & Kozlowski, 1995). All other studies using a knowledge test have included declarative knowledge questions only. In the current investigation, a knowledge test will be used to verify expert and novice participants. A strength of the current study is that a knowledge test with both declarative and procedural knowledge questions will be used.

Overview of the Variables

This investigation sought to further identify task process differences between experts and novices. As indicated previously, a variety of task process differences between experts and novices have been identified. However, additional research is needed in domains and contexts that have not been previously studied. For example, differences in the way experts and novices use relevant and irrelevant information is an issue that needs to be addressed further. Why? Given the theoretical claim that distinguishing relevant from irrelevant information is a defining characteristic of experts and novices, it is important to obtain additional findings beyond what have already been reported in the literature.

Previous expertise research has found differences between experts and novices in the recall, search, and identification of relevant and irrelevant information. All of these studies have measured relevant and irrelevant information as dependent variables. In other words, researchers have presented experts and novices with a particular task and subsequently measured how much of the information recalled, searched, or identified by the participants was either relevant or irrelevant. No study to date has examined differences in expert and novice behavior across tasks that vary in their proportion of relevant and irrelevant information. By presenting different proportions of relevant and irrelevant information, it is possible to test whether the nature of the task itself moderates expert and novice task processes. Such an experiment may provide supportive, yet different information regarding the claim that experts are better able to distinguish relevant from irrelevant information. This investigation compared differences in information search of experts and novices and was the first experiment testing expert and novice differences to use relevance of information as an independent variable.

Expertise. The first independent variable in this study was expertise. The domain under investigation in this study was personnel selection. Expert and novice participants in this study were selected using a two-stage process. Participants were initially selected based on their experience with hiring decisions. Undergraduate students with at least some exposure to personnel hiring decisions were recruited as novices for the experiment. The experts for this study were individuals from the community with professional personnel selection experience. The recruitment of expert and novice

participants were verified with a knowledge test that taps both procedural and declarative knowledge within the domain of personnel selection.

A comment should be made about the choice of personnel selection as the domain for this study. A second contribution of this study is that it was the first within the expertise literature to examine information search differences between experts and novices in the domain of personnel selection. In general, a wealth of research has been conducted on personnel selection in terms of issues relating to selection standards, validity generalization, methods for selection, and appropriate predictors, to name a few. However, no study has compared the information search differences between experts and novices within the domain of personnel selection. The process of making appropriate personnel decisions is a complicated one that involves the evaluation of information derived from a variety of sources and formats, not all of which is equal in relevance to the situation. In addition, an individual making appropriate hiring decisions must consider contextual information as well as legal and ethical guidelines. Many hiring decisions are made in the workforce everyday and these decisions have clear implications for the successful functioning of organizations. As a result, the attempt to identify differences in personnel information search processes, as a function of expertise is a worthwhile pursuit.

Information relevance. The second independent variable in this study was information relevance. For this study, relevant information was defined as information diagnostic for the decision under consideration (Shanteau, 1988). Participants were asked to search information and make a decision among alternatives when presented with information that varies in its relevance to the decision task. One half of the participants

were presented with information that is all relevant to the decision task (high relevance condition). The other half of the participants were presented with some relevant and some irrelevant information to the decision task (low relevance condition).

Dependent variables. The dependent variables in this study were measured in the context of an information board methodology (discussed in greater detail in the method section). In studies using an information board, participants search pieces of information on a grid in order to make a decision among alternatives given a set of attributes for each alternative. Previously mentioned studies involving basketball decisions (Devine & Kozlowski, 1995) and selection of life insurance policies (Kuusela & Spence, 1998) utilized an information board methodology to study expert and novice decision-makers. The advantage of using an information board methodology to study information search is that various information processing variables, such as total time searching, total pieces of information searched, and search pattern, can be measured.

Several dependent variables were measured in this study. First, speed of information search was measured as the total number of seconds a participant takes to examine information on a given information board decision task. Second, the total amount of information searched was measured as the total number of pieces of information searched in making a decision. Also, for participants who receive an information board with some irrelevant information, the total number of irrelevant information pieces viewed was measured. Fourth, participants rated the relevance of each attribute they were presented with on the information board after completing the

decision task. These ratings of relevance were made using a six-point scale ranging from very irrelevant to very relevant.

In addition, the search pattern of each participant's decision was categorized as compensatory or noncompensatory. A measure of search variability was used to designate whether information search was compensatory or noncompensatory (Payne, 1976).

Predictions and rationale. The underlying goal of this study was to determine whether differences between experts and novices in task processing can be explained by the superior ability of experts to discriminate relevant from irrelevant information. Recall from previous research that differences have been found in the recall, search, and identification of relevant and irrelevant information (Coughlin & Patel, 1987; Ettenson et al., 1987; Patel et al., 1986; Spence & Brucks, 1997). More specifically, prior research has found that in tasks in which both relevant and irrelevant information is presented, experts seem to be able to ignore irrelevant information (Brucks, 1985; Hershey et al., 1990); this ability may explain why experts are more efficient at task processing than novices. However, there is no evidence to suggest that experts and novices differ in task processing in tasks where all the information presented is relevant. Thus, in this investigation, no differences in task processing were expected between experts and novices in the high relevance condition. Alternatively, in the low relevance condition, it was predicted that novices will look at more irrelevant information than experts.

Hypothesis 1: Within the low relevance condition, novices will search a greater number of irrelevant pieces of information than experts.

Given the premise and key prediction set forth in hypothesis one, this study also investigated the total pieces of information searched by experts and novices. Due to predicted differences in the number of pieces of irrelevant information searched by experts and novices in the low relevance condition, it was predicted that expertise and information relevance would interact to affect the total number of information pieces searched. Specifically, it was hypothesized that the total number of pieces of information searched in the high relevant condition would not differ between experts and novices. However, in the low relevance condition, total pieces of information searched by novices will be greater than experts due to their examination of more irrelevant information. The hypothesized interaction is depicted in Figure 1.

> Hypothesis 2: Information relevance will interact with expertise on amount of information search. Experts and novices will not differ in total pieces of information searched in the high relevance condition. In the low relevance condition, novices will search more total pieces of information than experts.

Using the same rationale as hypothesis two, hypothesis three suggests that a primary reason why experts search information more quickly is that experts are searching less information overall because they ignore irrelevant information. Hence, the form for the interaction between expertise and information relevance on total time of information search was identical to the form of interaction identified for hypothesis two. The hypothesized interaction was depicted in Figure 2.

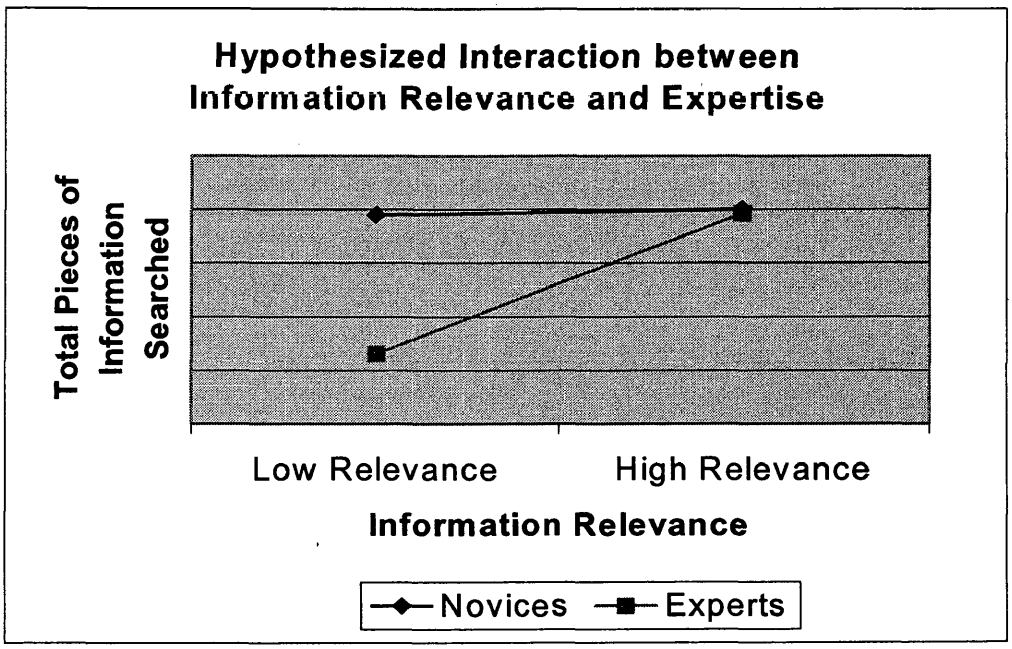

Figure 1. Hypothesized interaction between information relevance and expertise.

Hypothesis 3: Information relevance will interact with expertise on information search time. Experts and novices will not differ in total information search time in the high relevance condition. In the low relevance condition, novices will spend more total time searching information than experts.

The next hypothesis was related to the first three hypotheses in that it involves the issue of relevance of information. As an additional measure of the participant's ability to distinguish relevant from irrelevant information, each participant in the low relevance condition was asked to rate the relevance of the job applicant attributes presented in the decision-making portion of the task. As discussed earlier, previous research indicates that experts are better able than novices to use, recall, and identify relevant information.

Hypothesis 4: Experts' average ratings of relevance for relevant attributes will be significantly higher than experts' average relevance ratings for irrelevant attributes.

The final hypothesis for this investigation was exploratory in nature and involves the comparison of expert and novice search strategy. Previous research on expert versus novice decision-making has identified that experts and novices differ in their approach or strategy to decision-making. Chi, Feltovich, and Glaser (1982) found that differences exist in the way that experts and novices represent problems; novices use surface aspects and experts use more complex, theoretical aspects of the problem. This finding was supported by Scherer, Johanson, and Brown's (1999) study of loan officers.

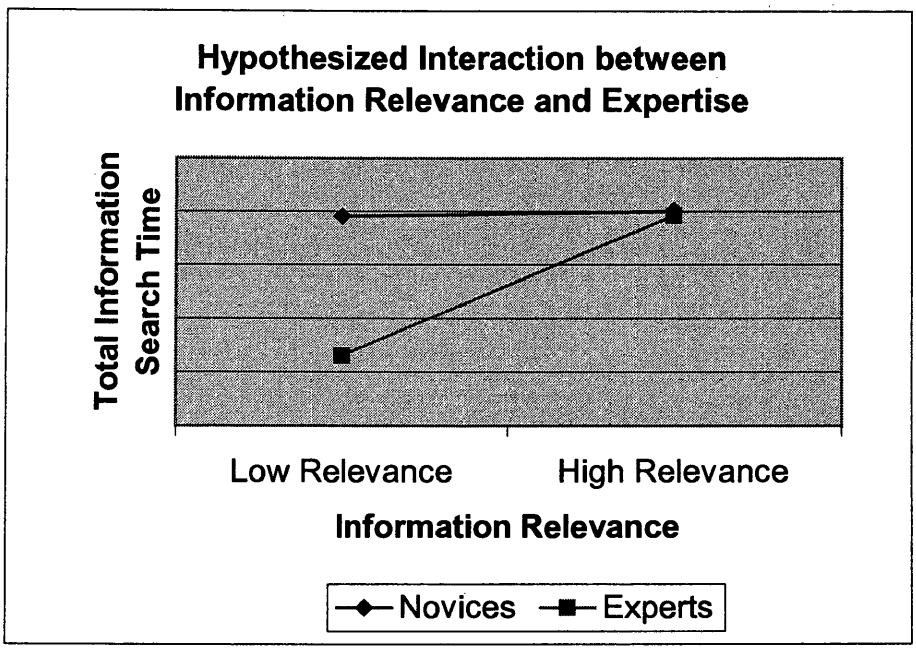

Figure 2. Hypothesized interaction between information relevance and expertise.

Corcoran's (1986) study of nurses found that experts initially start with a broad approach to the decision and alter their overall decision strategy based on the complexity of the problem. On the other hand, novices do not alter their strategy based on problem complexity.

In this study, the search strategy of experts and novices was classified as either compensatory or noncompensatory. Whether an information search strategy is compensatory or noncompensatory can be determined by calculating variability of information search, or the standard deviation of items searched per alternative. A high search variability is indicative of a noncompensatory search and a low search variability (nonzero) is indicative of a compensatory search. Only one previous study in the expertise literature has classified search strategies as compensatory or noncompensatory (Kuusela & Spence, 1998), yet no study of expertise has classified search patterns according to a participant's search of an information board (Payne, 1976).

Recall from earlier in the literature review that a noncompensatory search strategy is one in which a decision-maker is not examining all pieces of available information. Rather, the decision-maker may simplify the decision process by establishing a criterion for one or more of the decision attributes and eliminating all alternatives that do not meet this criterion (Payne, 1976). A compensatory search strategy is more effortful than a noncompensatory strategy and is defined as one in which the evaluation of an alternative is based on a combination of ratings of all the attributes for a given alternative (Payne, 1976). The use of a compensatory search strategy is one in which the value of attributes

rated as high for a given alternative can be traded off for attributes of the same alternative that are rated low.

As mentioned above, variability of search is a measure used to classify information search as either compensatory or noncompensatory. An additional measurement, search pattern, can be combined with variability of search to identify particular styles of compensatory and noncompensatory search strategy (See Appendix H). The determination of search pattern involves identifying whether an information search was predominately alternative-based or attribute-based (Billings & Marcus, 1983).

Two examples of compensatory strategies are the linear, or additive, model and the additive difference model (Payne, 1976) (Appendix H). Compensatory decision approaches involve a constant search pattern. Using the linear model, each alternative is evaluated separately. Using an information board, an interdimensional search suggests the use of a linear model. Each attribute of every alternative is weighted according to importance and then added to obtain an overall rating. These overall ratings are compared and the decision-maker selects the alternative with the highest rating (Payne, 1976). The additive difference model also involves rating each alternative across all dimensions (Tversky, 1969). Unlike the additive model, the decision process is ultimately intradimensional; the difference between alternatives across all dimensions is used to establish value ratings. This model is primarily used when two alternatives are present. Using an additive difference approach is quite complicated to employ beyond two alternatives.

Noncompensatory strategies do not involve trade-offs. Conjunctive and elimination-by-aspects (EBA) are examples of noncompensatory strategies (Appendix H). Using the conjunctive rule, alternatives are eliminated that do not meet a minimum criterion across each dimension (Svenson, 1979). As a result, use of the conjunctive rule can be described as an interdimensional search process (Billings & Marcus, 1983). EBA strategy, proposed by Tversky (1972), initially involves the evaluation of alternatives using the dimension deemed most important.

Elimination-by-aspects strategy is the most commonly observed noncompensatory strategy in the decision-making literature. In an information board study, an intradimensional search would be indicative of EBA (Billings & Marcus, 1983). Alternatives not meeting a minimum criterion along the first dimension are eliminated (Ford, Schmitt, Schectman, Hults, & Dohetry, 1989). A second dimension is selected and alternates are further eliminated. This process continues until all but one alternative is eliminated.

Further, Payne's (1976) study of information search strategy and information load revealed that under low levels of information load, operationalized according to the total number of pieces on an information board, participants will tend to use a compensatory search strategy. Under higher levels of information load, participants tend to switch to a more efficient, noncompensatory search strategy. For example, participants presented with a six-alternative by eight-attribute information board searched substantially fewer information pieces than participants presented with a six-alternative by four-attribute information board (Payne, 1976).

Focusing on this proposed study, it was expected that experts' ability to discriminate relevant from irrelevant information would lead to differences in search strategies according to information relevance condition. It was predicted that experts would examine a large proportion of the information presented on high relevance boards. Further, it was predicted that this search of a large proportion of information would lead to high information load and the adoption of a more efficient, or noncompensatory, search strategy. Alternatively, it was predicted that by ignoring irrelevant pieces of information, experts would effectively reduce the size of the low relevance boards such that examination of these boards would have a lower information load. Consequently, this lower level of information load would lead to the use of a more thorough, or compensatory, information search strategy by experts.

Novices' inability to discriminate relevant from irrelevant information was expected to lead to the examination of a large proportion of information regardless of the information relevance condition. The overall examination of a large proportion of information, and thus a high information load, was predicted to result in novices' use of a noncompensatory search strategy for both high and low relevance information board conditions.

> Exploratory hypothesis. Experts will use a different search strategy based on information relevance condition. Experts will search a greater number of information boards using a compensatory search in the low relevance condition and search a greater number of information boards using a noncompensatory in the high relevance condition. Novices will search a

greater number of information boards using a noncompensatory search in both the high and low information relevance conditions.

Method

In this section, the procedures used to conduct two pilot studies and the primary study are described. The pilot studies outlined below were conducted to develop the decision tasks and the knowledge test used in the primary study. Following the discussion of the two pilot studies, the primary study is described in detail, including the study's experimental design, the manipulation of independent variables, materials and experimental task, dependent measures, and experimental procedure.

Pilot Study 1: Information Relevance Ratings

The first pilot study was conducted to collect ratings of job applicant attributes for use in establishing the information relevance manipulation for the main study. The rating procedure used for establishing relevance of information was modeled closely after the work of Coughlin and Patel (1987). Coughlin and Patel (1987) asked six physicians to provide relevance ratings to develop a medical decision making task.

First, a job was selected for use in the decision-making tasks in the experiment. The job of museum curator was selected as the position to be used in the experiment. The goal in selecting a job for the study was to choose a complex job that participants would not have a great deal of previous knowledge about but could understand what the job entails after being given a job description and other information about the position. It was important to select a reasonably obscure job for this experiment so that no individual

or group might come into the experiment with substantial knowledge about the field or job.

After constructing a job description for the museum curator position, as well as creating background information about the organization, a list of 37 potential attributes about a candidate applying for the job was developed (Appendix B). Examples of these attributes include personality characteristics, academic history, work history, and selection test scores. An operational definition was created for each attribute and examples of scores or attributes were generated as well.

Participants

Seven doctoral level I/O psychology graduate students and three Ph.D. graduates of an I/O psychology graduate program served as participants for this pilot study. These participants were considered to "expert judges" given their knowledge of employee selection theory and principles. All of the doctoral students and Ph.D. graduates had professional experience involving the employee selection process.

Task and Procedure

Participants were given a packet of materials that included experimental instructions, a job description for the position of museum curator, and a rating sheet with all 37 job attributes, their definitions, and examples. Participants were asked to review the job description and then rate the relevance of each of the attributes in terms of use in selecting the best applicant for the job of museum curator. The scale used for rating the relevance of attributes was a six-point scale ranging from very irrelevant to very relevant.

Upon completion of the ratings, the experimenter informed the participants of the purpose for obtaining the ratings and the participants were thanked for their time.

Results and Discussion

The purpose in gathering relevance ratings from experts was to develop a final experiment with a decision task that had the most powerful information relevance manipulation possible. In order to develop a strong information relevance manipulation, it was important that redundancy in the attributes presented to participants be eliminated and that differences between relevant and irrelevant attributes be large, yet not so large that the decision task lacked face validity for expert participants.

To begin the attribute selection process, the mean relevance ratings for each of the 37 attributes were calculated. Ratings for all attributes were then compiled and ranked according to the mean relevance rating for each attribute. The data was initially divided such that the most relevant third of the attributes and the least relevant third of the attributes were initially considered as relevant and irrelevant attributes, respectively.

The procedure for selecting the four irrelevant attributes to be used in the study was as follows. First, out of the 12 attributes retained in the lower third of the tripartite split, the six attributes rated most relevant (those with the highest mean relevance rating) were discarded. Of the six remaining attributes, "astrological sign" was removed given its probable low face validity and "region of birth" was removed given that a similar attribute, place of birth, was retained. The four remaining attributes had an overall mean rating of 1.25 on a six-point scale.

The procedure for selecting the relevant attributes was as follows. As discussed above, the goal with respect to obtaining relevant attribute ratings was to develop an experimental task with a powerful information relevance manipulation. Information boards used in the primary study were to contain eight attributes about job candidates. Thus, eight attributes needed to be selected for use in the in the high relevance condition; four out of those eight attributes would be used in the low relevance condition.

Out of the 12 attributes retained in the upper third of the tripartite split, the four attributes rated least relevant (those with the lowest mean ratings) were discarded. The eight remaining attributes had an overall rating of 5.28 on a six-point scale. These were the eight attributes selected to comprise the high relevance information board.

In designating four of the eight relevant attributes for the low relevance information boards, the least relevant attributes (those with the lowest mean rating) were discarded, leaving five attributes. In order to maximize the power of the information relevance condition, an attempt was made to remove any single attribute that might dominate other attributes as being obviously relevant. As a result, the knowledge test attribute was removed; it was given the highest rating, or most obvious, of the remaining attributes. Also, removal of the knowledge test attribute allowed for there to be a balance of attributes that could be reasonably found on a job application ("last position" and "work experience") and two attributes that involve some type of testing ("simulated speech" and "writing sample"). See Appendix G for a list of the attributes selected for use on the information board in the primary study.

Pilot Study 2: Knowledge Test Development

The second pilot study involved the development and preliminary administration of an employee selection knowledge test. This knowledge test was constructed for use as a check of participants' domain knowledge in the primary study. The questions on the test consisted of both declarative and procedural knowledge questions derived from multiple sources. Questions were sampled from organizational psychology and human resources management texts (Mathis & Jackson, 1997; Muchinsky, 2000) and I/O psychology faculty members' personal test question banks. In addition, questions were written to reflect comments made by three human resources professionals interviewed by the investigator. In these interviews, the human resources professionals were asked to review a preliminary sample of knowledge test questions and point out other important issues regarding employee selection, particularly issues requiring procedural knowledge. The preliminary version of the pilot test contained 48 items total: 39 multiple-choice and nine true-false questions.

Participants

Ten undergraduates enrolled in a psychology course served as novices for this pilot study. All of these participants had been involved in at least two hiring decisions as the job applicant. Course credit was given for participation in the study.

Seven doctoral level I/O psychology graduate students and three Ph.D. graduates of an I/O psychology graduate program served as experts for this pilot study. These participants were considered to be appropriate approximations to the experts sampled for

the final study given their knowledge of employee selection theory and principles. In addition, all of the doctoral students and Ph.D. graduates had professional experience involving the employee selection process.

Task and Procedure

The knowledge test was administered to participants individually or in small groups. Upon entering the study site, participants were asked to read and sign an informed consent document. A copy of the 48-item knowledge test was distributed to each participant. The participants were instructed to follow the directions at the top of the page and to mark their answers directly on the test. Upon completion of the test, the experimenter explained the purpose of the pilot test and participants were thanked for their participation. Undergraduate participants were given a card documenting their participation.

Results and Discussion

The preliminary version of the knowledge test was administered to obtain an initial comparison of a sample of experts and novices and to evaluate some general psychometric properties of the test. Coefficient alpha for the knowledge test was 0.91, indicating a high level of internal consistency. Each knowledge test was scored and the number of questions answered correctly was calculated. The mean scores obtained by the expert and novice groups were compared using a Students's t-test. When all original 48 test items are considered, experts scored significantly higher than novices on the knowledge test, t (18) = 7.78, p<.01. Experts obtained a mean score of 37.5 out of 48 (78% correct) and novices obtained a mean score of 21.8 (45% correct).

An item discrimination analysis was conducted to examine how well each item differentiated expert versus novice knowledge on the test. The index of discrimination (d) was used to evaluate each item (Anastasi & Urbina, 1997). The index of discrimination is calculated by subtracting the percentage of participants who correctly answer a question in one group from the percentage of participants who correctly answer the same question in another group. Values for d can range from +100 to –100. Although simple to calculate, d yields similar results to much more complex item discrimination methods (Anastasi & Urbina, 1997). For this analysis, the percentage of novices who answered a particular question correctly was subtracted from the percentages of experts who answered the question correctly. Thus, larger d scores reflected a greater discrimination between expert and novice participants.

The purpose for conducting the item discrimination analysis was to remove items from the test that did not differentiate expert versus novice level of knowledge. An additional goal of the item discrimination analysis was to shorten the test length. Knowledge tests of approximately 30 items have been successfully used in expertise studies in the past (Brucks, 1985; Devine & Kozlowski, 1995; Hershey et al., 1990; Kuusela & Spence, 1998). Also, given that Human Resources Professionals would be donating part of a workday to this study, it was desirable that the length of the entire experimental procedure be kept to one hour or less. Items with a d of 20 or less were removed from the final version of the test, eliminating 18 questions from the test. The 30 questions (25 multiple-choice and 5 true-false) included in the final version of the test are included in Appendix A. When the 30 final test items are considered, experts scored

significantly higher than novices on the knowledge test, t (18) = 9.06, $p<.01$. Experts obtained a mean score of 26 out of 30 (87% correct) and novices obtained a mean score of 11.7 (39% correct).

Primary Study

Design

In this experiment, I utilized a 2 x 2 (Expertise x Information Relevance) between-participants factorial design.

Manipulation of Independent Variables

Expertise. The expert and novice groups for this experiment were initially selected based on level of education and professional experience with hiring decisions. The novices in the experiment were undergraduate students at the University of Nebraska at Omaha who: (a) were enrolled in a psychology course at the University of Nebraska at Omaha and (b) have been involved in at least two hiring decisions as the job applicant. The second criterion ensured that the novice participants had at least some exposure to hiring decisions. These volunteer participants were given extra credit in exchange for their participation.

The expert participants were individuals from the community who had: (a) at least two years of professional personnel selection experience, and (b) at least a bachelor's degree in business, I/O psychology, human resources, or a similar degree. Two years of professional experience is within the range of criteria used in previous studies (18 months for nurses (Corcoran, 1986) to 15 years for real estate appraisers (Spence & Brucks,

1997). Expert participants were initially sampled from a list of alumni of the UNO I/O psychology graduate program.

The knowledge level of the participants in each group was verified with a multiple-choice and true/false test in the domain of personnel selection (Appendix A). The development of this knowledge test was described in Pilot Study 2.

Information relevance. The relevance of information presented was manipulated by varying the proportion of relevant attributes presented on the information board. The process for selecting attributes for the information boards was described in Pilot Study 1. In the high relevance condition, all eight attributes presented on the information board were relevant to the position of museum curator. Alternatively, in the low relevance condition, participants were presented with four relevant and four irrelevant attributes.

Participants

Participants in the novice sample were 40 undergraduate students enrolled in a psychology course at the University of Nebraska at Omaha. This portion of the sample consisted of 11 male and 29 female participants. All of these participants had been previously involved in at least two hiring decisions as the job applicant: 26 had been involved in two to three hiring decisions, nine had been involved in 4-10 hiring decisions, and five had been involved in 11-30 hiring decisions.

The expert participants in the study were 40 human resources professionals from the Omaha area. This portion of the sample consisted of 15 male and 25 female participants. Twenty-three of the participants (57.5%) held bachelor's degrees and 17 participants (42.5%) held master's degrees in business, I/O psychology, human resources,

or a similar degree. The expert participants in the study possessed a mean of 10.24 (median 7.5, SD = 8.3) years of professional experience in employee selection. Further, 62.5% of the expert participants had achieved Professional in Human Resources (PHR) or Senior Professional in Human Resources (SPHR) certification at the time of the study.

Experts scored significantly higher than novices on the test of employee selection knowledge, $t(78) = -17.70$, $p < .001$. On average, experts answered 23.3 questions correctly (77.6%) and novices answered 12.5 questions correctly (41.7%) out of 30 questions total.

Materials and Task

Participants were presented with a scenario in which they were asked to assume the role of a Personnel Director for a foundation that operates a number of art museums. Participants reviewed a job description for the position of 20th Century American Art Curator within this organization. Upon review of the job description, participants used an information board to select the best candidate among six applicants for the hypothetical job of 20th Century American Art Curator. Participants actually selected the best candidate for openings in two museums operated by the same organization. Eight attributes or characteristics were presented for each of the six job applicants on the information board. There were two possible levels, a high and a low level, for each of the attributes and levels were designated to each candidate so that no candidate has a superior rating across all of the attributes. In particular, the boards were constructed so that one of the six candidates was high on six of the eight attributes. One of the five remaining candidates was high on five, four, three, two, or one attributes.

In order to view attribute information for a job candidate, participants removed a card from an envelope on the board. Participants turned cards around one at time and placed them back in their envelope so that the attribute information for that job candidate was visible for the remainder of the decision task. After participants examined as much information as they wished, they handed the experimenter a card with the initials of the best candidate. The experimenter recorded the search pattern used by the participant and documented the amount of time taken to complete each decision task using an information board.

Following the information board procedure, participants were asked to rate each of the eight attributes in terms of how relevant the information was to them as they made the hiring decisions. Participants used a six-point scale ranging from one (very irrelevant) to six (very relevant).

Dependent Measures

Speed of information search. Speed of information search was measured as the total number of seconds the participant used an information board. This measurement was made starting from the first piece of information on the board that the participant examined for the selection of a candidate.

Quantity of information search. Quantity of information searched was measured as the total number of pieces of information viewed during a given information board decision task.

Quantity of irrelevant information search. Quantity of irrelevant information search was measured as the total number of irrelevant information pieces viewed during a given information board task.

Relevance of information rating. The relevance of the job applicant attributes was measured using a six-point scale ranging from very irrelevant to very relevant. Participants were asked to consider relevance of information as the extent to which a given attribute provided any meaningful or useful information to aid in the selection of a curator. Participants rated each of the eight attributes they are presented with using this scale.

Compensatory versus noncompensatory search strategy. This dependent measure was used to test the exploratory hypothesis in the experiment. When using an information board methodology, the pattern and variability of a participant's search provide an indication of compensatory versus noncompensatory search strategy (Billings & Marcus, 1983). Measures of information pattern and variability allow the researcher to classify the information search process utilized by a decision-maker (Appendix H). The information search strategy for each decision task in this experiment was classified as either compensatory or noncompensatory. The frequency with which compensatory and noncompensatory strategies was used by experts and novices in both the high and low relevance conditions was calculated to test the exploratory hypothesis.

A compensatory strategy is one in which attributes of an alternative are weighted in such a way that values low in one dimension can be traded off against high values on another dimension (Payne, 1976). A compensatory strategy is characterized by a constant

search pattern such that a person using this type of strategy searches the same number of information pieces per alternative.

A noncompensatory strategy is characterized by a variable search pattern (Billings & Marcus, 1983; Ford et al., 1989). A person using a noncompensatory search strategy uses a variable number of information pieces per alternative. A noncompensatory search strategy may involve eliminating alternatives that do not meet a minimum requirement for one, several, or all attributes.

For this experiment, a measure of search variability, or standard deviation of the number of items searched per alternative was used to designate whether the information search was compensatory or noncompensatory (Payne, 1976). A low search variability suggests a compensatory strategy while a high search variability suggests a noncompensatory strategy.

Procedure

Participants were tested individually in sessions lasting 45 to 60 minutes. All novices were tested in an experimental lab room at the University of Nebraska at Omaha. Expert participants were tested at the same location at the University of Nebraska at Omaha or at their place of employment in an office or conference room. Participants were given initial oral instructions from the experimenter (Appendix E) to begin the experimental session, then read and signed an informed consent document explaining the purpose of the experiment and the nature of the tasks involved (Appendix C). Participants were given a packet that included an explanation of the role they were to

assume for the personnel selection task as well as the job description for the position of museum curator (Appendix E).

After participants adequately reviewed the packet, they informed the experimenter and then sat down in front of an information board to begin the information board task (Appendix D). At this time, the participants were given a paper copy of the attributes, including their definitions, that were presented to them in the information board tasks to follow. It should be noted that the participant was allowed to refer to the job description, attribute list, and any notes they have taken at any time throughout the information board tasks.

The experimenter read the participants directions regarding the information board task. Participants performed a practice exercise in which they selected a candidate for the job of museum curator using an information board with the same attributes that were presented in the experimental decision tasks. Following the practice decision task, participants performed two experimental trials in which they used an information board to select who they thought was the best candidate for the job of museum curator.

After completion of the two information board decisions, half of the participants rated the relevance of the attributes presented for the candidates using a six-point scale (very irrelevant to very relevant). Next, these participants completed the personnel selection knowledge test consisting of multiple-choice and true/false questions. The other half of the participants completed the knowledge test first and then the attribute ratings. The knowledge test was given after the information board tasks so that it would not cue participants to any of the critical issues relating to proper personnel selection

practices. For participants in the high relevance condition, the attribute ratings served as a manipulation check of the extent to which the attributes were considered relevant. For participants in the low relevance conditions, the attribute ratings were used to test hypothesis four.

Participants then completed a short demographic questionnaire (Appendix F), were debriefed, and thanked for their participation. The novice participants received extra-credit for their participation in the experiment.

Results

Overview of Analyses Performed

A Student's t-test was used to test hypothesis one. Specifically, the total number of irrelevant pieces of information viewed by experts and novices in the low relevance condition was compared. A t-test was computed to examine the difference between the average of the total number of irrelevant information pieces viewed by experts and novices across both information board tasks.

The Scheffe test for planned comparisons was used to analyze components of the proposed interaction between expertise and information relevance on (a) total amount of information search (hypothesis two), and (b) amount of information search time (hypothesis three). Information search time and total amount of information search were computed by averaging the values for each participant across the two information board tasks.

To test hypothesis four, the ratings of experts in the low relevance condition were used. The mean relevance rating made by experts across all relevant attributes was

calculated. The mean relevance rating made by experts across all irrelevant attributes was calculated. These mean scores were compared using a Student's t-test.

The exploratory hypothesis was tested using a Log-linear Multiway Frequency Analysis. This Log-linear analysis of experts' and novices' use of compensatory versus noncompensatory search strategy was followed up with several chi-square tests. Search variability was used as the measure of compensatory versus noncompensatory strategy. An information search with a variability of zero was classified as compensatory. An information search with a nonzero variability was classified as noncompensatory (Payne, 1976). The frequency with which compensatory and noncompensatory search strategies were used was pooled across all expert and novice participants. An alpha of .05 was used to test all hypotheses.

Hypothesis 1: Search of irrelevant information. This hypothesis stated that novices would search a greater number of irrelevant pieces of information than experts. Consistent with this hypothesis, novices in the low relevance condition searched a significantly greater number of irrelevant pieces of information ($M = 11.23$, $SD = 4.70$) than experts ($M = 1.70$, $SD = 2.37$) in the low relevance condition, $t(38) = 8.10$, $p < .05$.

Hypothesis 2: Amount of information search. This hypothesis proposed an interaction between expertise and information relevance. More specifically, it was hypothesized that experts and novices would not differ in the amount of information pieces searched in the high relevance condition, yet novices would search more information than experts in the low relevance condition.

Given the specific directional nature of the hypothesized interaction, a Scheffe test for planned comparisons was used to test the components of the interaction. The Scheffe test was selected because it is the most versatile and conservative of the planned comparison tests (Pedhazur & Pedhazur Schmelkin, 1991).

Table 1 displays the means and standard deviations of quantity of information searched by experts and novices by information relevance condition. Planned comparisons revealed a significant interaction consistent with hypothesis two. In the low relevance condition, experts searched significantly less information than novices, Scheffe $q = 139$, $p < .05$. In the high relevance condition, experts and novices did not significantly differ in the quantity of information searched, Scheffe $q = 67$, $p > .05$. This interaction is depicted graphically in Figure 3.

Hypothesis 3: Total information search time. Similar to Hypothesis 2, this hypothesis proposed an interaction between expertise and information relevance. More specifically, it was hypothesized that experts and novices would not differ in total information search time in the high relevance condition yet novices would spend more time searching information than experts in the low relevance condition.

As with Hypothesis 2, given the specific directional nature of the hypothesized interaction, a Scheffe test for planned comparisons was used to test the components of the interaction. Table 2 displays the means and standard deviations of total information search time of experts and novices by information relevance condition. Planned

Table 1

Means and Standard Deviations for the Quantity of Information Pieces Searched as a Function of Expertise and Information Relevance

	Information Relevance	
	High	Low
Expert		
M	37.73	24.00
SD	9.73	4.68
Novice		
M	34.37	30.67
SD	7.01	5.92

Note. $N = 80$. The values represent the mean number of information pieces searched across the two information boards.

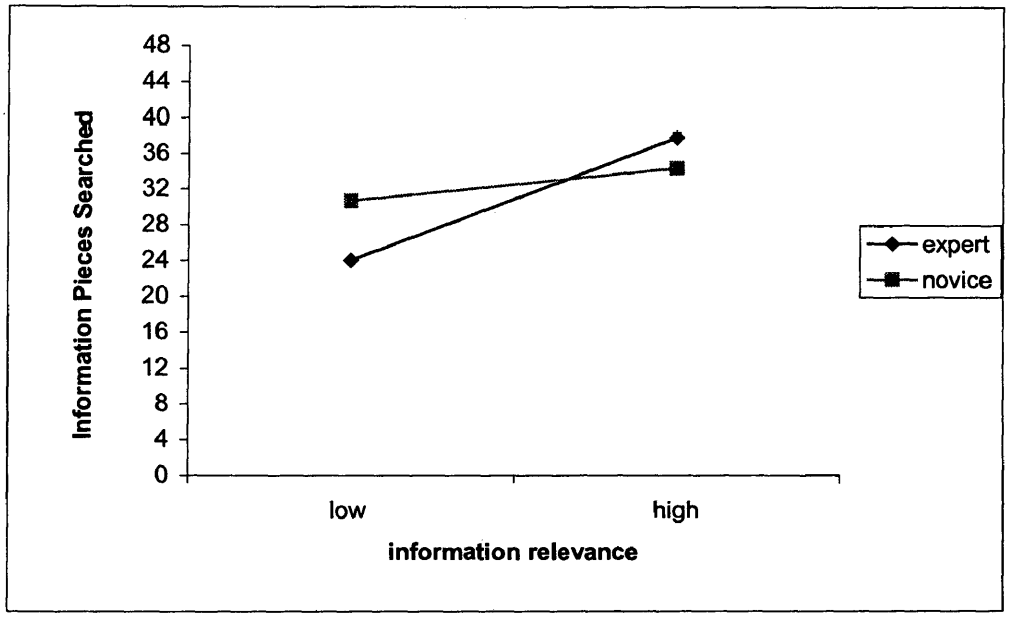

Figure 3. Mean number of information pieces searched as a function of expertise and information relevance.

Table 2

Means and Standard Deviations for Total Information Search Time as a Function of Expertise and Information Relevance

	Information Relevance	
	High	Low
Expert		
M	187.25	124.60
SD	63.60	40.09
Novice		
M	184.58	152.50
SD	57.39	49.57

Note. $N = 80$. The values represent the mean number of seconds information was searched across the two information boards.

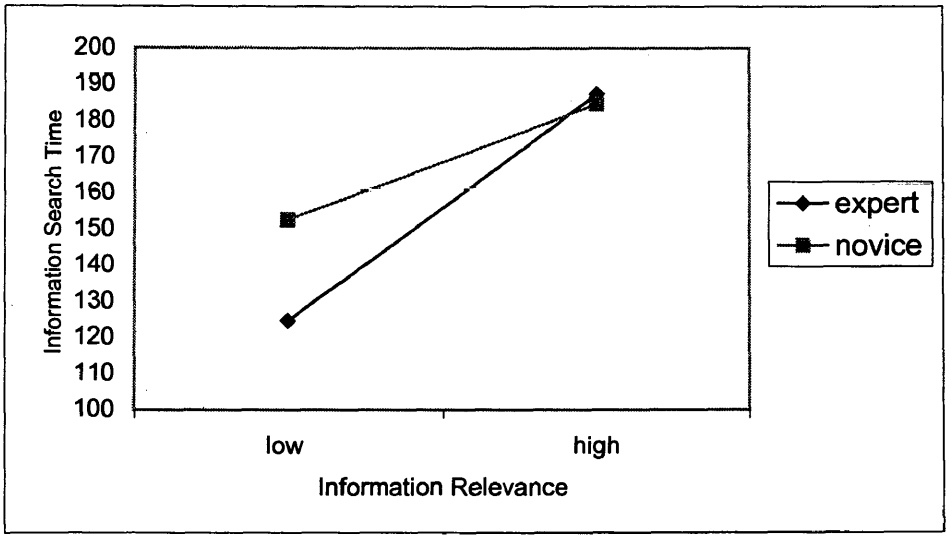

Figure 4. Mean information search time (seconds) as a function of expertise and information relevance.

comparisons revealed a pattern of data consistent with the relationship outlined in Hypothesis 3.

In the low relevance condition, experts spent less time searching information than novices; however, this difference was not statistically significant, Scheffe $q = 55.8$, $p > .05$. In the high relevance condition, experts and novices did not significantly differ in the time of information search, Scheffe $q = 51$, $p > .05$. This pattern of data is depicted graphically in Figure 4.

To further investigate differences between expert and novice information search time, a less conservative test than the Scheffe test was performed post hoc. A post hoc one-tailed t-test indicated that experts ($M = 152.5$ seconds, $SD = 49.57$) searched information in the low relevance condition significantly faster than novices ($M = 124.6$ seconds, $SD = 40.09$), $t(38) = 1.96$, $p < .05$.

Hypothesis 4: Relevance ratings. This hypothesis states that experts would rate relevant attributes presented on the information boards as significantly more relevant than irrelevant attributes. A Student's t-test of the experts ratings in the low relevance condition indicated that experts rated relevant attributes significantly higher ($M = 5.9$, $SD = 0.31$) than irrelevant attributes ($M = 1.80$, $SD = 0.70$), $t(38) = -24.10$, $p < .05$. Thus, hypothesis 4 was supported.

To further investigate differences between how participants rated attributes, a post hoc test compared how experts and novices in the low relevance condition rated relevant versus irrelevant attributes. To perform this post hoc test, a difference score was created

for each participant that represented the participant's mean rating of relevant attributes minus the participant's mean rating of irrelevant attributes. If experts were able to identify relevant from irrelevant information better than novices, then mean difference scores for experts should be significantly greater for experts than novices. Indeed, a one-tailed t-test indicated that mean difference scores for experts ($\underline{M} = 3.99$, $\underline{SD} = 0.69$) were significantly greater than mean difference scores for novices ($\underline{M} = 2.19$, $\underline{SD} = 0.79$), $\underline{t}$ $(38) = -7.70$, $\underline{p} < .05$.

Exploratory hypothesis: Information search strategy. I hypothesized that experts would more frequently use a compensatory search strategy in the low relevance condition and a noncompensatory search strategy in the high relevance condition. Further, I hypothesized that novices would more frequently use a noncompensatory search strategy in both the high and the low relevance condition.

I performed a three-way frequency analysis in an attempt to develop a log-linear model of expert and novice information search strategy. Variables analyzed in this frequency analysis were information search strategy, expertise, and information relevance condition. Log linear analysis was an appropriate statistical technique because it is used to test the associations among three or more categorical variables. Used in this way, log linear analysis functions as a nonparametric analysis of variance for categorical variables (Tabachnick & Fidell, 1989).

The log-linear analysis revealed that a three-factor model did not provide a good fit for describing the data, likelihood ratio χ^2 $(3) = 4.4$, $\underline{p} > .05$. Rather, only the two-factor association between expertise and search strategy provided a significant effect.

Given that only one two-factor association in the analysis was significant, no further analysis could be conducted using the log linear approach.

An alternative analysis of the exploratory hypothesis was conducted to examine the relationship between information relevance, expertise, and search strategy. Admittedly, it is considered inappropriate to test a hypothesis again after first finding a nonsignificant result. However, given that this hypothesis was exploratory in nature, it was important to find a way to analyze the data in any way that might describe an interesting pattern or association.

As a result, two chi-square analyses between expertise and search strategy, separated by high and low information relevance condition, were performed as a way to look at the possible interaction between expertise and search strategy. First, a chi-square analysis of expertise and search strategy for low relevance information boards was significant, χ^2 (3) = 8.40, $p < .05$. In other words, there was a significant relationship between level of expertise and information search strategy for participants in their search of low relevance boards. Similarly, a chi square analysis of expertise and search strategy for high relevance information boards was significant, χ^2 (3) = 18.99, $p < .05$. In other words, there was a significant relationship between level of expertise and information search strategy for participants in their search of high relevance boards.

Examination of the frequency of compensatory and noncompensatory search strategy use by experts and novices indicates a pattern that is consistent with the exploratory hypothesis. Tables 3 and 4 provide a summary of expert and novice search strategy according to information relevance condition. Figure 5 graphically depicts the

frequency of compensatory and noncompensatory search strategy for both experts and novices. As indicated on Tables 3 and 4, experts used a compensatory search strategy more frequently (55%) when using low relevance boards and used a noncompensatory search strategy more frequently (60%) when using high relevance boards. In addition, novices used a noncompensatory strategy 87.5% of the time regardless of information relevance condition.

Table 3

Compensatory versus Noncompensatory Search Strategy Frequency and Percentage by Expertise Level and Information Relevance Condition

		Low Relevance		High Relevance	
		Frequency	Percentage	Frequency	Percentage
Expert	Compensatory	22	55.0	16	40.0
	Noncompensatory	18	45.0	24	60.0
Novice	Compensatory	5	12.5	5	12.5
	Noncompensatory	35	87.5	35	87.5

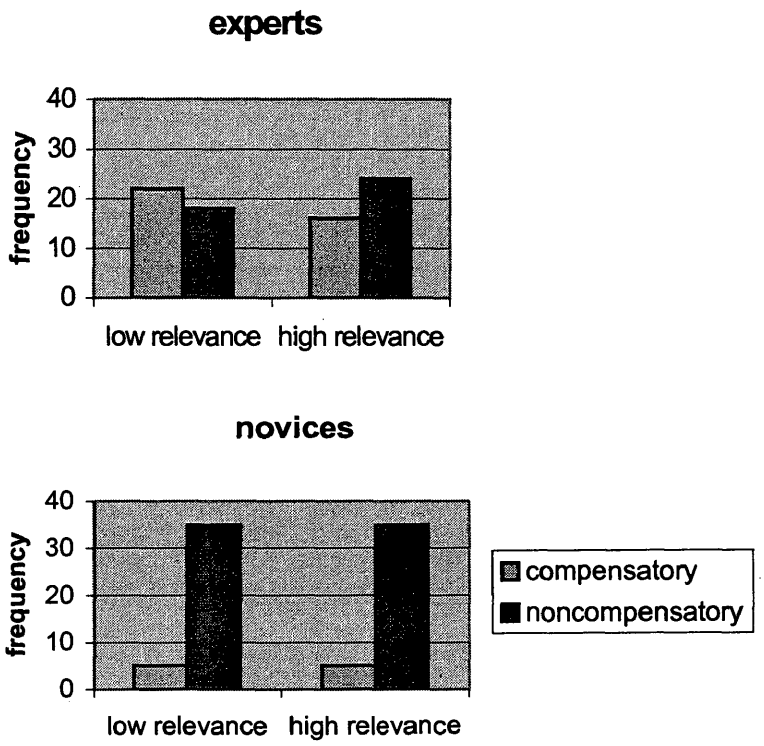

Figure 5. Frequency of Compensatory and Noncompensatory Search Strategy by Expertise Level and Information Relevance Condition.

Table 4

Information Search Strategy Frequency and Percentage by Expertise Level and Information Relevance Condition

		Low Relevance		High Relevance	
		Frequency	Percentage	Frequency	Percentage
Expert	Compensatory				
	Additive difference	21	52.5	14	35.0
	Linear	1	2.5	2	5.0
	Noncompensatory				
	EBA	14	35.0	17	42.5
	Conjunctive	4	10.0	7	17.5
Novice	Compensatory				
	Additive difference	4	10.0	5	12.5
	Linear	1	2.5	0	0.0
	Noncompensatory				
	EBA	20	50.0	26	65.0
	Conjunctive	15	37.5	9	22.5

Discussion

The overall goal of this study was to examine information-processing differences between experts and novices. More specifically, this study sought to answer the following question, "Given a decision making task, in what ways does the relevance of information presented influence information search for experts and novices?" The current study provides evidence that begins to answer this question. Indeed, it appears that a difference in the ability to distinguish relevant from irrelevant information is an important factor to consider when comparing expert and novice decision making. Evidence from this study show that experts and novices differ in the amount of information they search, the time they take to search information, and the overall search strategies they use.

In this study, experts were adept at identifying relevant from irrelevant information. Results of the experiment indicated that the information relevance manipulation was a strong one. Experts not only searched significantly less irrelevant information than novices (Hypothesis 1) but experts also correctly distinguished relevant from irrelevant attributes when making ratings of the attributes (Hypothesis 4). Further, a post hoc test indicated that the difference between experts' mean ratings for relevant and irrelevant attributes was significantly larger than difference between novices' mean ratings for relevant and irrelevant attributes. Considered together, findings from tests of hypothesis 1, hypothesis 4, and the above-mentioned post hoc test are consistent with previous studies that found experts were proficient at identifying irrelevant information

(Coughlin & Patel, 1987; Ettenson et al., 1987; Patel et al., 1986; Spence & Brucks, 1997).

The current study went a step further and tested the influence of information relevance on the amount of information search and time of information search. It was predicted that given an expert's superior ability to ignore irrelevant information, experts would search less information (Hypothesis 2) and spend less time searching information (Hypothesis 3) than novices when presented a low relevance information board. In addition, it was predicted that experts and novices would not differ in amount of information search (Hypothesis 2) or information search time (Hypothesis 3) when presented a high relevance information board.

Analysis of Hypotheses 2 and 3 indicated that information relevance was a moderator of expert and novice information search behavior. Experts and novices in the high relevance condition did not differ significantly in total information search time or the number of information pieces searched. In the low relevance condition, experts searched significantly less information than novices and took less time. Use of a Scheffe test for the analysis of Hypothesis 3 indicated that the difference in information search time between experts and novices was not significantly different. However, a less conservative post hoc test indicated that experts searched information significantly faster than novices in the low relevance condition.

In addition to looking at the statistical differences in search time between experts and novices in the low relevance condition, it is noteworthy to simply look at the practical significance of this difference in search time. Experts searched the low

relevance board an average of almost 30 seconds faster than novices. Thirty seconds was a substantial amount of time in this task given that the entire search task typically took a participant between 2 to 3 minutes to complete.

This study's findings suggest that the proportion of relevant information presented to a decision maker have an impact on information search processes. Recall that the underlying premise of this study was that experts distinguish relevant from irrelevant information, which in turn allows experts to examine less information and be more efficient decision makers overall. By ignoring irrelevant pieces of information on the low relevance boards, experts in this study looked at fewer pieces of information and did so in less time. Tests of Hypotheses 1 through 4 provide a consistent trend of data to support Shanteau's (1992) theoretical claim that the ability to distinguish relevant from irrelevant information is one of the characteristics that differentiates experts from novices.

Considered in isolation, these findings are interesting and useful in providing further empirical evidence regarding the differences between expert and novice decision makers. However, the contribution of this study to the decision-making literature is not fully realized without also comparing the search strategies utilized by experts and novices.

A number of previous studies have utilized an information board, or similar methodology, to investigate information search strategies (e.g. Bettman & Park, 1980; Capon & Burke, 1980; Isen & Means, 1983; Johnson & Meyer, 1984; Klayman, 1985; Kuusela & Spence, 1998; Olshavsky, 1979; Onken, Hastie, & Revelle, 1985; Payne, 1976; Sundstrom, 1984). With the exception of two of these studies (Bettman & Park,

1980; Kuusela & Spence, 1998) the participants were novices in the decision domain. Of the studies that used a compensatory versus noncompensatory framework to classify decision strategy, participants were found to predominantly use a noncompensatory search strategy. For example, in (Sundstrom, 1984), college students chose an apartment using an information board. Only six of the 96 subjects ever used a compensatory search strategy. In Isen & Means' (1983) study of mood's effect on information search, none of the subjects ever used a compensatory search strategy.

Across the above-mentioned studies, the use of a noncompensatory strategy was observed only in conjunction with increased task complexity. Task complexity was typically increased by adding alternatives or attributes to an information board. A consistent finding across previous studies was that as task complexity increased, number of information pieces searched decreased and use of noncompensatory search strategies increased (Johnson & Meyer, 1984; Klayman, 1985; Payne, 1976; Staelin & Payne, 1976).

In light of previous findings, it is important to point out the patterns of information search strategy displayed by experts and novices in this study: experts varied their search strategy based on the relevance of the data presented and novices did not. In both the low and high relevance conditions, novices predominately used a noncompensatory search strategy. In fact, novices used a noncompensatory strategy for 87.5% of the information boards, regardless of the information relevance condition. This pattern is consistent with previous studies that found noncompensatory search strategies to be used most frequently by participants who are novices in a decision domain. On the

other hand, experts switched strategies depending on information relevance. When presented a low relevance information board, experts used a compensatory strategy more frequently. When presented a high relevance information board, experts were more likely to use a noncompensatory strategy.

The above-mentioned pattern of search strategy by experts and novices is a fascinating finding. There are three explanations for this pattern of search strategy. The first explanation relates to the notion of cognitive laziness. Cognitive laziness refers to idea that people take mental shortcuts, such as looking at only a portion of available information, in order to process the massive amount of stimuli that exist in the environment. Simplifying, or noncompensatory, information search strategies can be thought of as cognitive shortcuts because people are searching less than all available information. In this study, novices used noncompensatory search strategies for nearly 90% of the information boards regardless of information relevance condition. Experts used a mix of both compensatory and noncompensatory search strategies. If use of compensatory search strategy can be thought of as one indicator of cognitive laziness, then novices were more cognitively lazy than experts in this study. However, it is unfair to represent noncompensatory search strategies as completely negative because use of noncompensatory search strategy can also be viewed as efficient and directed. So in other words, noncompensatory should not necessarily be equated with cognitive laziness. When expert versus novice differences on measures such as amount of information search are compared, cognitive laziness does not make sense as an explanation for the results. There was no significant difference in the number of pieces experts and novices

searched in the high relevance condition. The notion of cognitive laziness is an interesting concept as relates generally to expert and novice differences, but by itself, does not provide a compelling explanation for the data in this study.

A second explanation for the pattern of search data in this study is the notion of cognitive flexibility. In the context of this study, cognitive flexibility refers to a person's ability to use different strategies or approaches to make decisions. It could be the case that experts are simply more flexible in their approach to decision making. In this study, experts varied their search strategy based on the complexity of the data presented. Experts in the low relevance condition tended to use compensatory search strategy, while experts in the high relevance condition tended to use a noncompensatory search strategy. Novices were inflexible decision-makers, using noncompensatory strategies regardless of the relevance of information provided. This pattern of flexibility on the part of experts and rigidity on the part of novices is consistent with Corcoran's (1986) study of hospice nurses. Corcoran found that experts varied their overall decision approach based on the complexity of the task while novices did not.

Although the data from this study indicated that experts adjust their search strategy based on information relevance and novices do not, additional data would need to be collected to accept cognitive flexibility as the most compelling explanation for this study. For example, data from this study provides no clue to the mechanism, or the *how*, that might allow experts to be more flexible in their information search approach. This greater flexibility could be due to having a larger repertoire of strategies to choose from, or alternatively, the flexibility may simply be a result of expert's superior domain

knowledge. Future research is needed to identify and then tease apart the factors that influence expert's potentially greater decision making strategy flexibility.

Perhaps the best explanation for the pattern of search strategy use in this study relates to the notion of cognitive load. Cognitive load is one way to increase the complexity of a task. In an information board task, cognitive load can be increased by adding either more alternatives or more attributes to each board. In this study, experts actually decreased the cognitive load of the information boards by ignoring the four irrelevant attribute columns provided on the low relevance boards. By ignoring these four attributes, experts effectively reduced the size of the information board from 48 pieces (6 applicants by 8 attributes) to 24 pieces (6 applicants by 4 attributes). Previous studies have shown that participants only switch from a noncompensatory strategy to a compensatory strategy when the task complexity decreases (Johnson & Meyer, 1984; Klayman, 1985; Onken et al., 1985; Payne, 1976; Staelin & Payne, 1976). In other words, participants tend to use a simplifying strategy (noncompensatory strategy) unless the information load is small enough that it is reasonable to use a more exhaustive search strategy (compensatory). In this study, experts ignored irrelevant attributes, were able to then concentrate on a small number of remaining attributes, and used a compensatory search strategy. Data from this study suggests that novices have a less of an ability to discriminate the degree of relevance of information such that all boards are seen as high relevance, and consequently, all boards are high in cognitive load. As a result of searching information boards as if they were all high in cognitive load, novices tended to use less effortful, noncompensatory search strategies.

Future study should be conducted to gain a better understanding of why experts and novices differ in their use of search strategies when relevant and irrelevant information is presented. Future research should test if the failure of novices to switch strategies and consequently use noncompensatory search is merely an artifact or the result of their poor discrimination ability and tendency to see all decision tasks as uniformly similar and complex. Corcoran's (1986) study of expert and novice nurses suggests that novices view all decision as complex. Alternatively, all three explanations described above could be at work at the same time. Put in this light, one interesting and appropriate follow up study would be to pit the "ability to discriminate relevance of information" explanation of expert and novice differences against the "ability to change strategies based on decision task" explanation. If expert versus novice differences are due to flexibility in strategy usage, then novices should fail to switch decision strategy even when explicitly told what is relevant versus what is irrelevant information. However, if novices do switch strategies from a noncompensatory to a compensatory strategy after being told which information is relevant versus irrelevant, then the importance of information relevance would seem to be a better explanation of expert versus novice differences.

Limitations

The use of an "information board only" methodology was a limitation in that such a design does not allow for decision making strategies to be fully identified. In some previous studies, a combination of information board and verbal protocol methods were used (Payne, 1976; Payne & Braunstein, 1978). By combining both methods, an

experimenter is able to not only track the search pattern of a participant but record the participant's "think aloud" comments as they search information. If verbal protocol data were collected in this study, strategies utilized by participants could have been identified though both quantitative analysis of search patterns and coding of protocols. The scope of this project and the demands of collecting the information board data with a single experimenter made collection of verbal protocols impractical.

From the point of view of one researcher, it is not appropriate to use an information board in an expert versus novice decision making study. Brucks (1985) suggested that the use of a structured method for presenting information to participants eliminates some of the decision making advantages that experts have over novices. In other words, an information board may provide novices with a representation of the available information in a way that experts have mentally prior to the beginning of the experiment. If this criticism of information board designs were true, one would expect to find no expert versus novice differences using such an experimental design. However, a number of expert versus novice differences were found in this study.

For Hypothesis 4, it could be said that a limitation of the study was power, or sample size. If the study included more than 80 subjects, it is likely that a significant difference would have been found between expert and novice search time in the low relevance condition. However, overall, power was not a concern in this study given that three of the four hypotheses were confirmed with only 20 participants in each of the four conditions.

Implications

This study contributes to the existing decision making literature in several ways. First, the results of this study support previously reported task-processing differences between experts and novices, namely that experts search less information in less time than novices. Second, this study documents a significant moderating role of information relevance, a variable that has not been examined in any previous studies of expert and novice information search. The results of this study fit nicely with previous expertise studies that have used information relevance as a dependent variable. Third, the current study is a contribution to the decision-making literature given that it demonstrates expert versus novice differences in the domain of personnel selection. The group of Human Resource practitioners who served as experts for this study had more domain-specific experience and a measurably higher level of knowledge relating to employee selection than the novices in the study. Little, if any, previous research has been conducted that directly tests decision making differences of experts and novices in the domain of personnel selection (Beach, Mitchell, Deaton, & Prothero, 1978; Rice, 1975).

The results of this study have exciting potential application for use in training HR professionals. A knowledge test such as the one created for this study may be a useful assessment tool for instructors teaching selection workshops or professional certification courses. In addition, teaching the use of a decision strategy similar to an information board may be a useful way to help HR professionals learn how to document their hiring decisions. In hiring decision with multiple applicants, it is important that the relevant information be structured and organized in a way that can be readily evaluated. It is important to note that six of the experts in this study independently mentioned that they

use something similar to an information board when evaluating job candidates. Expert participants said they use a grid to organize information, to standardize their selection procedure, and to create documentation of the process used to select candidates in the event of a discrimination lawsuit. These comments lend credence to the external validity of the study.

Future Research

In the current study, participants were allowed to take as much time as they wished to search the information boards. Imposing a time limit on each decision is one way that the demands of the task could have been increased. When Payne, Bettman, and Johnson (1986) imposed a time limit, participants looked at fewer pieces of information, focused on more important attributes, made more attribute-based searches, and showed more variation in search pattern. Time pressure would be a useful variable to cross with expertise and information relevance in future studies. For example, it would be interesting to know if time pressure would lead to experts overcoming their tendency to use a compensatory search strategy when presented a low relevance board. Also, would experts and novices react differently to time pressure and search more or fewer pieces of information when searching a high relevance board?

Another task moderator that should be examined in future studies is the task length/fatigue effects. Recall that the current study required participants to look at only a total of three information boards. If the number of decision tasks were increased, changes in search strategy may occur simple from fatigue. Billings and Scherer (1988) found that participants predominately used noncompensatory strategies toward the end of

a decision making task that involved eight information boards. In the personnel selection domain, fatigue effects are an important consideration in situations in which a large number of candidates are reviewed in a short period of time.

The current study utilized university students and Human Resource professionals as novice and expert participants, respectively. Follow up studies should include novices and experts who all have at least some professional hiring decision experience. For example, Human Resource professionals with less than six months of experience and those with more than 5 years of experience could be compared. Further, more than two levels of expertise could be compared within the same study (i.e. novice, intermediate, and expert).

Future research should investigate situational moderators that may further explain the relationship between expertise and information relevance. It is important to point out that the task in this experiment was an exercise involving hypothetical applicants and an imaginary organization. Although the results of one study suggests that decision-makers rate real and hypothetical job applicants similarly (Cleveland, 1991), the external validity of the current study is limited by the fact that it was only an exercise. Also, unlike this study, people making a real hiring decision initially have the ability to choose what applicant information they will collect. This involvement in information collection may impact the eventual information search strategy that is adopted. The external validity of the findings from this study would be bolstered if future studies arrived at similar findings using real applicant data or in situations in which the decision-making strategies used in actual hiring decisions were analyzed. The practical application of findings from

this study rests upon whether or not the patterns of behavior for experts and novices hold when making real hiring decisions.

On a related note, it would be interesting to see if the importance of a real life hiring decision had an impact on information search strategies. In other words, might an expert ignore a high level of information load and use a compensatory search strategy if the hiring decision was particularly important to the organization? Also, would the importance of a hiring decision facilitate the retrieval or identification of the most relevant information?

Similar to importance of the decision, the competition that exists for an open position might have an impact on the strategy that a HR professional might use to make a hiring decision. For example, if a HR professional was faced with selecting one applicant out of more than 100, he or she might start out using a noncompensatory strategy to narrow the field. However, after the field was narrowed, the HR professional might use a compensatory search strategy and look at all available information thoroughly.

Another situational moderator to consider is the level of stress and anxiety that the participant experiences while making the hiring decisions. In this study, participants made hypothetical hiring decisions in a presumably low anxiety and low stress context. Janis and Mann's (1977) work on hot cognitive processes suggests that further research might reveal expert versus novice differences under situations of low and high stress. In a study on learning, Braunstein-Bercovitz, Dimentman-Ashkenaki, and Lubow (2001), studied the effects of state-based anxiety and presentation of irrelevant information on a participant's ability to discriminate letters. One of the findings of this study was that

state-based anxiety inhibits a person's ability to screen out previously presented irrelevant information. When participants were initially shown an irrelevant piece of information, high state anxious participants made more errors and took longer to complete a series of letter discrimination tasks compared to low state anxious participants.

Though the negative effects of anxiety on learning have been well documented, Braunstein-Bercovitz, Dimentman-Ashkenaki, and Lubow's (2001) study underscores the importance of information relevance as a potential mediator of the anxiety-performance relationship. Further, this study suggests that future research determine whether the obtained state anxiety effects on learning extend to the information search domain, a question not previously addressed in the decision making literature. Even more germane to this study is the future examination of the effects of state-based anxiety and information relevance on the information search of experts and novices. One research question would be, "would a highly state anxious expert (perhaps manipulated via time pressure or threats to self esteem) fail to discriminate the degree of information relevance, and consequently, exhibit information search behavior more typical of a novice?"

Future studies of Human Resource expertise should attempt to tease apart the two main components of expertise, experience and knowledge. The domain of employee selection provides a useful arena for this pursuit because there are managers, I/O psychologists, and HR professionals who have varying levels of both experience and technical knowledge in the selection of employees.

Given that the information relevance manipulation used in this study was the first of its kind in the expertise literature, subsequent research should manipulate information relevance using more than one level or proportion. Adding additional levels of the information relevance manipulation would allow researchers to identify how sensitive experts are to irrelevant information and this data may also help provide data to help explain such phenomena as the dilution effect (Nisbett, Zukier, & Lemley, 1981; Tetlock & Boettger, 1989).

It is possible that individual difference variables may have played a role in the differences in time of information search in this study. Based on the observation of participants during data collection, it appeared that some of the variation in information search time was due to individual differences in the way that participants interacted with the board. Some participants turned over several cards at a time and then examined the information on the cards. Others stopped to evaluate cards individually after each was turned over. Some participants took time to write notes on scratch paper or refer back to the job description, and other participants did not.

Future expert versus novice studies involving information boards should measure various individual difference variables as possible explanations for the variation in the time of participant information search. Variables such as need for cognition (Cacioppo, Petty, & Koa, 1984) may help explain people's general tendency to look at a large or a small amount of information. Knowledge of search strategies might be a useful individual difference variable to examine as well. Using a verbal protocol methodology

in combination with an information board approach would provide more information regarding the strategies used by experts and novices.

Follow-up studies should use a computerized information board format. With a computerized information board, more sensitive information search time measurements could be taken. In addition, information search time could be studied in more detail by focusing on particular segments of the information search process.

Conclusion

This study provides a meaningful addition to the accumulating body of knowledge in the area of expert decision making. First, this study successfully demonstrated expert versus novice differences in a domain that had not been previously studied. Second, this study provides an example of a comprehensive approach to identifying experts. Participants for this study were selected based on both domain knowledge and experience/credentials. Most expertise studies have tended to use only one of these criterion. Third, compelling evidence was gathered in support of Shanteau's theory that the ability to distinguish relevant from irrelevant information is a defining characteristic of experts. Further, expertise seems to involve both the ability to ignore irrelevant information and an understanding of which information search strategy to use under different circumstances. By being able to ignore the irrelevant information, experts are faster decision-makers who are less susceptible than novices to situations of high cognitive load. Finally, this study identifies the information board methodology as an appropriate format for both the future study of personnel selection and as a vehicle for training proper hiring decision techniques.

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Appendix A

Knowledge Test

Appendix A

Please read each of the following questions carefully. For the multiple-choice questions, please circle the letter corresponding to the best answer. For the true/false questions, please write either a "T" or "F" in the space provided. Answer every question.

Multiple Choice

1. The _____ is a standardized data source provided by the U.S. department of Labor.
   a. Description of Job Information
   b. Occupational Title Index
   c. Dictionary of Occupational Titles
   d. Dictionary of Job Titles

2. If adverse impact is found to exist in a selection procedure, an employer must
   a. use score adjustments as a means of attaining employment fairness
   b. validate the selection procedure
   c. provide minorities with reasonable accommodations
   d. make back-pay settlements to individuals who have failed the test

3. Which of the following statements is NOT true regarding the Americans with Disabilities Act?
   a. Former illegal drug users are protected by the act
   b. It is the most significant piece of legislation ever enacted for individuals with disabilities
   c. An employment test can no longer screen out an individual with a disability
   d. The law states that employers must provide disabled persons with "reasonable accommodation"

4. Which court case established that the burden of proving the fairness of a selection test rests with the employer?
   a. Griggs v Duke Power Company
   b. Albermarle v Moody
   c. Bakke v University of California
   d. Washington v Davis
   e. None of the above

5. The reliability of a test indicates
   a. how accurately a test measures a characteristic
   b. how consistently a test measures a characteristic
   c. the difficulty of a test

d. the appropriateness of the test

6. Which of the following represents the appropriate order of events in the process of validating a test?
   a. test development, job analysis, association of test performance with job performance
   b. association of test performance with job performance, test development, job analysis
   c. job analysis, test development, association of test performance with job performance
   d. test development, association of test performance with job performance, job analysis

7. Which of the following is a conclusion from interview research?
   a. interviewers make up their minds early in a selection interview
   b. interviewers spend most of their time in a search for positive information about the applicants
   c. interviewers who follow a structured interview guide exhibit poor interrater reliability
   d. interviews are one of the best methods of selection

8. Which of the following statements about assessment centers is FALSE?
   a. research has shown prevalent racial and sexual bias
   b. assessment ratings more strongly predict advancement than performance
   c. assessment center participants may be able to fashion their behavior to impress assessors
   d. assessment centers may last from one to several days

9. Which of the following statements about letters of recommendation is TRUE?
   a. they are no longer commonly used for selection
   b. they are as valid as biographical inventories
   c. negative and positive letters are given equal weight
   d. employers receive only a small percentage of negative letters

10. Which of the following is NOT true about the task inventory (task analysis) method of job analysis?
   a. courts tend to prefer it for establishing content validity
   b. it is generally a very time consuming procedure
   c. it emphasizes the human abilities needed to perform tasks
   d. it produces a list of tasks required by the job

11. A catalog company specializing in maternity-wear hires only women models. This company can claim that being female is a(n) _____ for this job.
    a. affirmative action requirement
    b. realistic occupational requirement
    c. bona fide occupational qualification
    d. affirmative occupational qualification

12. Obtaining judgments from subject matter experts (SME's) regarding the extent to which knowledge, skills, and abilities are relevant to performing job tasks is an approach used to establish
    a. concurrent validity
    b. content validity
    c. predictive validity
    d. construct validity

13. According to Equal Employment Opportunity Commission guidelines, we do not need to validate which of the following selection devices, even if adverse impact results from this use?
    a. intelligence tests
    b. personality tests
    c. interviews
    d. all selection devices must be validated if adverse impact is found

14. A multiple hurdle selection strategy is one in which
    a. applicants must be interviewed by several members of the organization
    b. applicants must initially have a minimum score on a particular test or criterion to be given further consideration
    c. applicant's files are reviewed by looking at all test scores and all criteria before making any decisions
    d. applicants are selected based on the collective evaluation of several members of the organization

15. The agency(ies) responsible for enforcing employment-related provisions of the 1964 Civil Rights Act is
    a. The Equal Employment Opportunity Commission
    b. The Department of Labor
    c. The Justice Department
    d. The Office of Federal Contract Compliance Programs
    e. Both a and d above

16. "Employers identify problem areas, set goals, and take positive steps to guarantee employment opportunities for people in a protected class" is a definition of
    a. cultural diversity

b. affirmative action
c. diversity management
d. reverse discrimination

17. The Age Discrimination in Employment Act protects individuals over the age of
a. 30
b. 40
c. 65
d. 70

18. Which question cannot legally be asked during pre-employment interviews?
a. Are you a Veteran?
b. Are you married?
c. What are your career goals for the next five years?
d. How long did you hold your last job?
e. None of the above can be legally asked

19. The 1978 Uniform Guidelines make it clear that Human Resource requirements must _____ if employers are to defend their actions as job related
a. apply to all employees
b. be tied to specific job factors
c. not discriminate against protected-class members
d. be limited to actual on-the-job behaviors

20. The 4/5ths rule for determining disparate impact suggests that
a. 4/5ths of all minorities interviewed must be hired
b. Discrimination exists if the selection rate for any protected group is less than 4/5ths or 80% of the selection rate of the majority group
c. 4/5ths of all minorities hired must be African American
d. none of the above

21. Which of the following is of the LEAST value to a potential employer?
a. academic transcripts
b. financial references
c. law enforcement reports
d. personal references

22. According to the Americans with Disabilities Act, if medical exams or background checks are performed, they should be conducted
a. prior to interviewing a job candidate
b. within two days of interviewing a job candidate
c. after a conditional job offer has been made
d. following an applicant's acceptance of a position

23. It is NOT discriminatory during pre-employment inquiries to inquire about
    a. the birthplace of an applicant
    b. sex of an applicant
    c. prior job training of an applicant
    d. marital status of an applicant

24. If interviewing someone for a police officer position, which type of interview might help identify how the applicant handles a crisis?
    a. non-directive interview
    b. planned interview
    c. group interview
    d. stress interview

25. Susan is interviewing three candidates for a job from 9AM to Noon in three consecutive one-hour sessions. The first two candidates are poorly qualified. The third candidate is given a favorable rating. The rating of the third candidate could be the result of a
    a. first impression error
    b. contrast error
    c. similar to me error
    d. misrepresentation error

True/False

26. ____ The 1964 Civil Rights Act specifically states that employers may discriminate on the basis of sex, religion, or national origin if the characteristic can be justified as a bona fide occupational qualification.

27. ____ Personality tests can never be legally used for selection.

28. ____ In general, one should utilize a structured interview when hiring for jobs requiring well-defined tasks, whereas unstructured interviews should be utilized when selecting people for tasks requiring a high degree of creativity.

29. ____ On a job advertisement, the acronym EOE stands for Eligibility of Employment

30. ____ It is generally agreed that evaluations made in letters of recommendation are most objective and honest when a job applicant is given the opportunity to review the letters.

Appendix B

Pilot Test Attribute Ratings

Appendix B

Please read the following instructions carefully. As you read, imagine that you have been asked to assist the museum described in the instructions below.

A museum has an opening for the position of "20th Century American Art Curator." Due to the importance of this curator's position to the overall success of the museum, the board wants to ensure that a legal and high quality hiring process is employed. Your task is to provide feedback in the form of ratings to the board regarding the extent to which each attribute of job candidates listed below would be relevant or irrelevant to selecting the best person for the job. Your task is to provide feedback to the museum board regarding which criteria they should use in hiring for this position.

The museum has provided a job description of the curator's duties to help you evaluate the extent to which the criteria on the following pages would be relevant or irrelevant to making a high quality hiring decision that also conforms to legal guidelines.

(1) Review the job description provided until you are familiar with the minimum qualifications, critical tasks, supervision received, and supervision exercised for the job of "20th Century American Art Curator."

(2) After reviewing the job description, you are asked to use the six-point scale below to rate the relevance of each criterion in the selecting the best 20th Century American Art Curator. Circle the number corresponding to your rating. If you wish, you may refer to the job description as you make your ratings.

1 = Very Irrelevant
2 = Moderately Irrelevant
3 = Slightly Irrelevant
4 = Slightly Relevant
5 = Moderately Relevant
6 = Very Relevant

For example, if you believe that a criterion is highly relevant to selecting the best curator, then you would circle a "6". Alternatively, if you believe that a criterion is slightly relevant to selecting the best curator, then you would circle a "4".

Criteria	Definition of Criteria	Examples of Criteria	RATING
Most Recently Held Position	Position the applicant currently holds	a) Curator of 20th Century American Art at another museum b) Intern at another art museum c) Assistant Curator of American Art in this museum.	1 2 3 4 5 6
Interview Rating	Overall rating made by the personnel staff that interviewed the candidate. This rating a subjective estimation of the interviewer's perception of the applicant's ability to do the job. [Low Score = 0, High Score = 100]	a) 63 b) 74 c) 89	1 2 3 4 5 6
Letters of Recommendation	The content of three required letters of recommendations were rated by previous personnel staff as either highly favorable, somewhat favorable, favorable, somewhat unfavorable, or highly unfavorable.	a) 2 highly favorable letters and 1 somewhat favorable letter b) 1 highly favorable letters and 2 unfavorable letters c) 3 somewhat favorable letters	1 2 3 4 5 6
Personality Test Score (Big Five)	Applicants were administered the NEO personality questionnaire. This attribute refers to whether applicants were rated as either Introverted or Extroverted on the Extraversion scale of the questionnaire.	a) Introvert b) Extrovert	1 2 3 4 5 6
Cumulative Undergraduate GPA	Cumulative Grade Point Average earned across all undergraduate college courses.	a)3.7 b)2.8 c)2.2	1 2 3 4 5 6
Hobbies	Activity that applicant enjoys doing in his/her spare time	a)breeds and shows Wheaton Terriers b)cooking c)painting d)photography e)plays a musical instrument f)cycling	1 2 3 4 5 6
Astrological Sign	Astrological sign based on the applicant's day and month of birth	a)Taurus b)Capricorn c)Leo	1 2 3 4 5 6
Location of Birth	State or country in which applicant was born	a)Nebraska b)California c)Germany	1 2 3 4 5 6
Foreign Languages Spoken	Language other than English that applicant can speak proficiently.	a)None b)French c)Italian	1 2 3 4 5 6
Personal Characteristics	Marital status and number of children.	a)Married w/ 2 children b)Not married	1 2 3 4 5 6
Polygraph test	Asked questions related to trustworthiness and ability to manage money	a)Failed all questions b)Passed all questions c)Passed half of the questions	1 2 3 4 5 6
Residence history	Number of years applicant has lived in the city in which the job is located.	a)0 b)4 c)12	1 2 3 4 5 6
Typing Test	How many words per minute the applicant was able to type on a structured, 3 minute typing test.	a)18 b)33 c)49	1 2 3 4 5 6
Personality Test Profile (Enneagram Profile)	Based on an Enneagram Personality Profile Instrument, the applicant was classified as one of three personality types.	a) Type 3: A high energy work-a-holic. Aims to be successful at everything they do, an excellent communicator, motivator, and leader, strives to gain status and approval, communicates persuasively,	1 2 3 4 5 6

		sets goals and is organized. b) Type 4: Artistic, passionate person. Drawn to the heights and depths of emotional experience and to expressing themselves uniquely. Are very empathic to others, speaks in terms or feelings and communicate with sensitivity, sees possibilities in ordinary situations c) Type 8: Assertive, sometimes aggressive person who has an all or nothing approach to life, a born leader who is protective of friends and people in their care, knows what they think, concerned about justice and fairness, will not let themselves be controlled by others. Communicates in a blunt and direct manner about what is fair and just, speaks forcefully and confidently. Functions best when in charge of tasks completely.	
College Attended	Institution where applicant received highest level of education.	a)Harvard b)Penn State University	1 2 3 4 5 6
Travel experience	Degree to which the applicant has traveled in the United States and the world.	a)Traveled to all 50 states and spent 6 months studying and traveling in Europe b)Traveled the Eastern United states extensively, but only visited the west coast one time c) Has traveled to neighboring states of Nebraska.	1 2 3 4 5 6
Simulated speech to a board of directors	In an assessment center activity, applicants were given 15 minutes to prepare a 5-minute speech on how to increase the number of visitors to the museum. The speeches were rated using a series of benchmarks by a panel of trained judged. [Low score = 0, High score = 100]	a)89 b)74 c)63	1 2 3 4 5 6
Score on a knowledge test	This test is a multiple-choice test that includes questions relating to various artists and significant American works in the 20th century. [Low score = 0, High score = 100]	a)91 b)82 c)65	1 2 3 4 5 6
Level of education	The highest degree or level of education completed by the applicant.	a)MA in Art History b)MA in Art History and Museum Studies. c) BA in Museum Studies	1 2 3 4 5 6
Work experience in an art museum	Number of years experience working in an Art museum	a)0.5 b)2.5 c)4	1 2 3 4 5 6
Computer Knowledge	Types of programs the applicant has proficiency in using.	a) Word processing, Databases, Spreadsheet, and electronic communication programs b) Word processing c) Word processing, Databases, Spreadsheet, electronic communication programs, as well	1 2 3 4 5 6

		as a basic knowledge of computer programming.	
Managerial Experience	Years that applicant has held a job in which he or she had supervisory responsibilities.	a)0 b)1 c)3	1 2 3 4 5 6
General Mental Ability Test	Score on an IQ test as a general mental aptitude measure.	a)average b)slightly above average c)slightly below average	1 2 3 4 5 6
Writing Sample	In an assessment center setting, applicants were given 15 minutes to review various museum documents and then asked to write a letter to museum patrons that highlights the upcoming schedule of museum exhibits and activities. These letters were rated on a scale taking into account grammar, punctuation, organization, and style. [Low score = 0, High score = 100]	a)92 b)83 c)71	1 2 3 4 5 6
Volunteer Experience	Organizations/groups for which the applicant has helped with fundraising activities	a)None b)Church group c)United Way and Youth Soccer League	1 2 3 4 5 6
Professional Publications	Number of publications in museum related journals or periodicals	a)0 b)1 c)3	1 2 3 4 5 6
Vocabulary Test	A test of definitions of English language vocabulary. Words on the test were sampled from various versions of GRE-verbal practice tests. [Low score = 0, High score = 100]	a)89 b)71 c)64	1 2 3 4 5 6
Mathematical computation test	Basic arithmetic test of addition, subtraction, multiplication, and division.	a)94 b)78 c)82	1 2 3 4 5 6
Membership to Professional Organizations	Names of service/professional organizations to which the applicant belongs.	a)None b)American Association of Museum Curators c)Society of Professional Curators and Archivists	1 2 3 4 5 6
Physical Health Status	Self-report of applicant's health as generally good, average, or poor health.	a)Good b)Average c)Poor	1 2 3 4 5 6
Salary Requirements	Salary received by applicant at previous job.	a)32,000 b)41,000 c)48,000	1 2 3 4 5 6
Specialized Training	Training that the applicant has received beyond graduate or undergraduate school coursework.	a)None b)Attended sculpture appraisal workshop	1 2 3 4 5 6
Career Progression	Determination of whether applicant has taken positions of increasing responsibility and scope.	a)Yes b) No	1 2 3 4 5 6
Question about shyness	Applicants were asked on a questionnaire if they considered themselves to be shy	a)No b)Yes	1 2 3 4 5 6
Continuity of Employment History	Interviewer reviewed applicant's applications to determine any gaps in employment since completion of applicant's highest academic degree.	a)Continuous employment b)one three-month gap c)two six-month gaps	1 2 3 4 5 6

Appendix C

Informed Consent Document

Appendix C

Informed Consent Form

You are invited to participate in a research study. You are eligible to participate in this study if you are a student in an undergraduate psychology class at the University of Nebraska at Omaha (UNO) and can read and understand English. (OR You are eligible to participate in this study if you are a human resource professional and can read and understand English).

The purpose of this study is to investigate hiring decision processes. Your participation will take 45 to 60 minutes. You will be read a scenario and be asked to imagine yourself as a personnel director for a company. You will review a job description and then make several hiring decisions. After making the hiring decisions, you will answer several questions about hiring decisions and about yourself.

There are no known risks or discomforts associated with participating in this research.

If you choose to participate in this study, you may elect to receive a summary of the results so as to gain a better understanding of social science research. You will be awarded research exposure point(s) for every half-hour of participation. Your psychology course has alternative ways available to you to earn these points. (omitted for human resource professionals).

Your responses will be recorded by participant number, not by name. Your responses will be kept completely confidential and you will not be associated with the information you provide.

Participation in this study is voluntary. Your decision whether or not to participate will not affect your present or future relationship with the University of Nebraska at Omaha, the researchers, or your psychology instructor (omitted for human resource professionals). If you decide to participate, you are free to stop at any time. You will be given a copy of this informed consent form to keep.

I AM VOLUNTARILY MAKING A DECISION TO PARTICIPATE IN THIS STUDY. MY SIGNATURE CERTIFIES THAT I HAVE DECIDED TO PARTICIPATE HAVING READ AND UNDERSTOOD THE INFORMATION PRESENTED ABOVE.

_____ _____

Signature Date

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Appendix D

Experimental Stimulus Packet (Paper Handout)

Please Read The Following Information Carefully

- In a few minutes, you will be asked to make a series of hiring decisions.
- Before you make these decisions, you will need some background information.
- First, you need a description of the role you are being asked to assume for the remainder of this exercise. As you read, imagine that you are an employee of the organization in the description.

Your role

Recently, you were hired as the Director of Personnel for the Smith Foundation.
The Smith Foundation is an organization that is responsible for the management and operation of a number of art museums in the area.

One of your duties as the new personnel director is to select the best people for vacant positions.

Information about the Smith Foundation

Your new employer, the Smith Foundation, is a well-established organization committed to providing the public with the opportunity to view important pieces of art as well as other culturally, socially, and scientifically significant exhibits. The Smith Foundation realizes that the management of a high quality museum rests upon having a competent and effective staff. The Smith Foundation is committed to hiring the best people for the job based on qualifications of the applicant. The Smith Foundation has had a good record of complying with the Equal Employment Opportunity Commission and other hiring guidelines in the past.

Your Assignment

Today you need to make some decisions about who to hire for the position of curator at two of the museums that the Smith Foundation operates.

- The curator positions are important positions within each of the museums.
- These positions have remained unfilled for some time.

- Multiple applicants have applied for these positions, and you must develop a method for selecting the best applicant.

- The task of hiring new curators is especially important given that the people who previously held the vacant positions as curator were not doing an adequate job.
    - The work performed by the previous curators was a cause for complaints by both visitors and museum board members.

Information about Curator Position

- Members of your personnel department staff compiled some information about this position so that you could familiarize yourself with the requirements of the job.
- Your staff conducted a thorough job analysis of the position of curator that included the writing of a job description including a list of critical job tasks. The staff obtained this information through a process of interviewing and observing curators and interviewing their supervisors. The curators and supervisors were asked to provide ratings of the curator job tasks.

THE JOB DESCRIPTION INFORMATION COMPILED BY YOUR STAFF IS INCLUDED IN THIS PACKET.

Important Notes

- The previous Personnel Director completed all of the application process for the curator positions except for the actual hiring decisions.
- When you make the hiring decisions, you must use the information about the applicants for the curator positions that was collected before you took the position of Personnel Director at the Smith Foundation.
    - The information was collected using the selection tools and processes previously in place. The hiring tools and process used in the past were developed by staff who did not have experience in job analysis methods and the information collected was not based on job analysis information.
    - These previous procedures and tools for selection of employees were not validated.
- You intend to create your own set of selection tools, but you are faced with the immediate challenge of hiring and you cannot create your own selection tools at this time. You cannot obtain any additional information at this point and must use the information given to you.

At this time

1. Please review the job description provided in this packet.
    - You will be able to refer to this information as you make the hiring decisions, but it is important that you have a good sense of what the job of curator entails before moving on to the next part of the experiment.
    - Scratch paper is included in this packet if you wish to take notes as you review the materials.

2. Please review the job applicant attribute sheet (pink sheet)
    - The qualities or attributes on the pink sheet are the same attributes that will be provided for each job candidate. Take a moment to review the title and definition for each attribute; the definitions for each attribute will not be visible when you make your hiring decisions.

When you have finished reviewing the material in the packet, please let the experimenter know that you are ready to go on to the next part of the experiment.

CURATOR
20th CENTURY AMERICAN ART

NATURE OF WORK

Professional and administrative work involving the planning, oversight, cataloguing, safekeeping, arrangement, and exhibition of the museum's 20th century American Art Collection.

MINIMUM QUALIFICATIONS

Education and Experience

Completion of a master's degree in art history and/or museum studies. It is preferred that applicants have completed master's degrees in both art history and museum studies. Two to four years of work experience in an art museum is required.

CRITICAL TASKS

Administrative Duties

- Directs and supervises activities of a staff of six (assistant curators, museum technicians, and administrative support staff) engaged in planning and initiation of new exhibits and the maintenance of current exhibits. This supervision is carried out through both written and oral communication.
- Develops rapport with staff and motivates them toward accomplishing the goals of the 20th century American Art section of the curator's office.
- Speaks at board of director meetings to outline the budget for the 20th century American Art section of the curator's office or to present issues or concerns within the section.
- Develop and oversees the annual budget for the 20th Century American Art section of the curator's office.
- Meets with board of directors, museum director, and other museum administrative personnel to formulate and interpret policies, plan and implement exhibitions and public service activities, and plan overall museum operations.
- Authorizes all expenditures for new acquisitions made by the 20th Century American Art section of the curator's office.
- Assists museum director in interviewing and hiring of staff within the 20th Century American Art section of the curator's office.
- Writes reports to museum executive director and board of directors to keep them informed of activities taking place within the 20th Century American Art Section of curator's office.

Collections and Exhibitions

- Develops and maintains a computerized record keeping system for the 20th Century American Art collection that documents the inventory and location of works at all times.
- Develops and directs the proper storage of artwork not currently on display in the museum.
- Develops ideas for new collections or exhibits that will expand and improve educational and research facilities.
- Communicates and negotiates with administrators of other institutions to obtain loan collections or to exchange information or data. This communication may occur via email, written correspondence, phone, or in person.
- Makes decisions regarding the costs and benefits associated with acquiring or borrowing pieces of art that become available to the museum.
- Negotiates and authorizes purchase of pieces for the museum collection.
- Studies, examines, and tests acquisitions to authenticate their origin, composition, history, and current value.
- Reads technical or historical books and manuals to assist in the evaluation of an artwork's monetary value or to assist in decisions regarding the proper maintenance of artwork.
- Arranges insurance coverage for objects on loan or special exhibits, and recommends changes in coverage for entire collection.
- Reads current journal articles within the museum science field to remain current on the latest practices and important issues within the field.
- Inspects galleries to ensure that all artwork is properly displayed and labeled.
- Inspects galleries for evidence of deterioration and need for repair, specifically monitoring the condition of lighting systems, audio-visual equipment, display cases, and the climate control (heating and cooling) of the art gallery.
- Writes grant proposals for the purpose of securing funds for new acquisitions or exhibits.
- Reserves facilities for group tours and social events.
- Organizes and plans the annual exhibit schedule for the 20th Century American Art galleries.

Public Relations/Community Service

- Represents institution by speaking or attending scientific or association conferences.
- Gives presentations to tour or school groups who visit the museum and have a special interest in 20th Century American Art.
- Speaks at community meetings and civic events to promote interest and enthusiasm in the museum's programs and exhibits.
- Attends community meetings to maintain community alliances between citizens and the museum.
- Speaks at benefits and social functions to support the fund raising or membership goals of the museum.

- Conducts workshops and instructional sessions to acquaint individuals with the use of the institution's facilities and materials.
- Writes publicity and informational materials for distribution to patrons of the museum.

SUPERVISION RECEIVED
Direct supervisor is the museum's executive director. Work also falls under the supervision of the museum Board of Directors.

SUPERVISION EXERCISED
Responsible for the supervision of assistant curators, museum technicians, and administrative support staff within the 20th Century American Art section of the curator's office.

Appendix E

Information Board Instructions

Appendix E

Information Board Instructions

The next part of the study involves the selection of individuals for the position of curator. I will read the directions aloud and you may follow along with me as I read.

Information about each candidate is provided on an information grid, called an information board. First, you will have a chance to make a practice hiring decision to become familiar with using an information board. The practice information board contains the same qualities or attributes as the later information boards. Use this practice exercise to acquaint yourself with how to access information and make your selection as well as an opportunity to get familiar with the job candidate attributes.

Following the practice hiring decision, you will select candidates to fill the two vacant curator positions. Each of the information boards represents a set of 6 applicants for an open curator position. Consider each hiring decision to be a separate decision process. A particular candidate is included on only one board and these hiring decisions are for positions at different museums within the organization.

- Each row on the grid represents the information about a particular candidate. The labels on the left-hand side represent the initials of the 6 candidates for the job of curator.
- The labels across the top of the grid represent qualities or attributes about each candidate about each candidate.

<u>How to view the candidate information</u>

- Remove the card from one of the envelopes on the grid, turn the card around, and place the card back in the same envelope. The information on one card represents information relating to one candidate on one quality or attribute.
- You may look at as many or as few pieces of information as you wish.
- You may decide to look at more information for one candidate than another.

Use the information about the position of curator provided in the green packet (job description and attribute list) as well as your knowledge of and exposure to legal and high quality hiring policies and practices to select the best candidate for the job of curator out of six available applicants.

- Remember, you may refer to your packet of job information materials or notes you have made at any time during the process.
- If you wish, you may make notes on scratch paper as you review the information.

- Once you have selected the best candidate for the job of curator, hand the card with that applicant's initials to the experimenter.

I will remain in the room to ensure that there are no problems with the information board, but I will not be able to answer any questions once you begin your decision task. Do you have any questions regarding the information board or your decision task? Please begin your decision task now.

Now that you have practiced using an information board to make a hiring decision, you will be presented an information board from which you can select the best person for the first vacant curator position.

Remember to consider each hiring decision to be a separate decision process. A particular candidate is included on only one board.

The process for viewing information is the same as in the practice exercise

- Remove the card from one of the envelopes on the grid, turn the card around, and place the card back in the same envelope. The information on one card represents information relating to one candidate on one quality or attribute.
- You may look at as many or as few pieces of information as you wish.
- You may decide to look at more information for one candidate than another.

Use the information about the position of curator provided in the green packet (job description and attribute list) as well as your knowledge of and exposure to legal and high quality hiring policies and practices to select the best candidate for the job of curator out of six available applicants.

- Remember, you may refer to your packet of job information materials or notes you have made at any time during the process.
- If you wish, you may make notes on scratch paper as you review the information.

- Once you have selected the best candidate for the job of curator, hand the card with that applicant's initials to the experimenter.

I will remain in the room to ensure that there are no problems with the information board, but I will not be able to answer any questions once you begin your decision task. Do you have any questions regarding the information board or your decision task? Please begin your decision task now.

You have completed your first hiring decision and it is now time for you to review a second set of candidates for a position of curator that you must fill for a different museum operated by the Smith Foundation. Once again, you will be presented an information board from which you can select the best person for the first vacant curator position. For this position you must choose among the six candidates presented on the information board.

Remember to consider each hiring decision to be a separate decision process. None of the candidates reviewed for the first position are among the pool of candidates for this position.

The process for viewing information is the same as in the first two information board tasks

- Remove the card from one of the envelopes on the grid, turn the card around, and place the card back in the same envelope. The information on one card represents information relating to one candidate on one quality or attribute.
- You may look at as many or as few pieces of information as you wish.
- You may decide to look at more information for one candidate than another.

Use the information about the position of curator provided in the green packet (job description and attribute list) as well as your knowledge of and exposure to legal and high quality hiring policies and practices to select the best candidate for the job of curator out of six available applicants.

- Remember, you may refer to your packet of job information materials or notes you have made at any time during the process.
- If you wish, you may make notes on scratch paper as you review the information.

- Once you have selected the best candidate for the job of curator, hand the card with that applicant's initials to the experimenter.

I will remain in the room to ensure that there are no problems with the information board, but I will not be able to answer any questions once you begin decision task. Do you have any questions regarding the information board or your decision task? Please your decision task now.

You have completed all of the hiring decisions necessary to fill the vacancies for the position of curator within museums operated by the Smith Foundation. You will now be asked to answer a series of questions included in this blue packet. There are three sections to the packet. Please follow the directions for each of the sections. You may mark your answers to all of the questions directly on the packet materials. Please ask the experimenter if you have any questions.

You will be asked to review the job applicant criteria provided on the information board. Specifically, you will be asked to rate each of the attributes according to how relevant you felt the information was to the decision of making your hiring decisions.

For the purpose of this exercise, **relevance of information is defined as the extent to which a given attribute provided any meaningful or useful information to aid in the selection of a curator.**

In the empty box next to each attribute, type either a "1","2","3","4", "5", or "6" which corresponds to the scale provided on the following screen.

1 = Very Irrelevant
2 = Moderately Irrelevant
3 = Slightly Irrelevant
4 = Slightly Relevant
5 = Moderately Relevant
6 = Very Relevant

Criteria	Rating
Personal Characteristics	1 2 3 4 5 6
Location of Birth	1 2 3 4 5 6
Polygraph Test	1 2 3 4 5 6
Hobbies	1 2 3 4 5 6
Simulated Speech	1 2 3 4 5 6
Writing Sample	1 2 3 4 5 6
Art Museum Work Experience	1 2 3 4 5 6
Most Recently Held Position	1 2 3 4 5 6

You have now completed the computer-assisted portion of the study. At this time, please let the experimenter know you are ready to move on to the last portion of the experiment.

Appendix F

Demographic Questionnaire

Appendix F

Please read each of the following demographic questions and circle or write in your answer. Please answer all questions. Thank you.

What is your gender? (Circle one) MALE FEMALE

What is your age? (fill in years) ____

What is your race? (Check one)

Caucasian ___ African American ___ Hispanic ___
Native American ___ Asian American ___ Other ___

What is your highest level of educational experience? (check one)

High school graduate ___ Some college ___ Associate's or 2-yr. Degree ___
Bachelor's degree ___ Master's degree ___ Doctorate (M.D., Ph.D, or J.D) ___

Is English your primary language? (Circle one) YES NO

How difficult was it for you to read the materials in this experiment? (Check one)

Not at all difficult ___ Somewhat difficult ___ Difficult ___ Very Difficult ___

Prior to reading the job description of the position of curator, how familiar were you with the critical day-to-day duties of a curator? (Check one)

Not at all familiar ___ Somewhat familiar ___ Familiar ___ Very Familiar ___

I found this hiring decision task interesting? (Circle one)

Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree

The hiring task in this experiment seemed realistic. (Circle one)

Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree

How many years of professional experience do you have in making hiring decisions?

_____

For the following questions, indicate whether you have taken a college course (graduate or undergraduate) in a particular subject area

Have you ever taken a college course in (circle Yes or No):

			If yes, how many?		
Personnel Selection		YES	____		NO
Human Resource Management	YES		____	NO	
Industrial/Organizational Psychology		YES	____		NO
Business		YES	____		NO

Please read each of the following demographic questions and circle or write in your answer. Please answer all questions. Thank you.

What is your gender? (Circle one) MALE FEMALE

What is your age? (fill in years) ____

What is your race? (Check one)

Caucasian ___ African American ___ Hispanic ___
Native American ___ Asian American ___ Other ___

What is your current class standing in college? (check one)

Freshman ___ Junior ___ Other (please indicate) _____
Sophomore ___ Senior ___

Is English your primary language? (Circle one) YES NO

How difficult was it for you to read the materials in this experiment? (Check one)

Not at all difficult ___ Somewhat difficult ___ Difficult ___ Very Difficult ___

Prior to reading the job description of the position of curator, how familiar were you with the critical day-to-day duties of a curator? (Check one)

Not at all familiar ___ Somewhat familiar ___ Familiar ___ Very Familiar ___

I found this hiring decision task interesting? (Circle one)

Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree

The hiring task in this experiment seemed realistic. (Circle one)

Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree

How many hiring decisions have you been involved in as the job applicant? _____

For the following questions, indicate whether you have taken a college course (graduate or undergraduate) in a particular subject area

Have you ever taken a college course in (circle Yes or No):

		If yes, how many?	
Personnel Selection	YES	____	NO
Human Resource Management	YES	____	NO
Industrial/Organizational Psychology	YES	____	NO
Business	YES	____	NO

Appendix G
List of Attributes, Definitions, and Levels

Appendix G

High Relevance Condition

Writing Sample In an assessment center setting, applicants were given 15 minutes to review various museum documents and then asked to write a letter to museum patrons that highlights the upcoming schedule of museum exhibits and activities. These letters were rated on a scale taking into account grammar, punctuation, organization, and style. [Low score = 0, High score = 100]	High: 92 Low: 71
Managerial Experience Years that applicant has held a job in which he or she had supervisory responsibilities.	High: 3 years Low: 1 year
Level of Education The highest degree or level of education completed by the applicant.	High: MA in Museum Studies Low: BA in Museum Studies
Most Recently Held Position Position the applicant currently holds	High: Curator at another museum Low: Asst. Curator at another museum
Specialized Training Training that the applicant has received beyond graduate or undergraduate school coursework.	High: Sculpture Appraisal Workshop Low: None
Art Museum Work experience Number of years experience working in an Art museum	High: 4 years Low: 6months
Knowledge Test This test is a multiple-choice test that includes questions relating to various artists and significant American works in the 20th century. [Low score = 0, High score = 100]	High: 91 Low: 65
Simulated Speech In an assessment center activity, applicants were given 15 minutes to prepare a 5-minute speech on how to increase the number of visitors to the museum. The speeches were rated using a series of benchmarks by a panel of trained judged. [Low score = 0, High = 100]	High: 89 Low: 74

Low Relevance Condition

Writing Sample In an assessment center setting, applicants were given 15 minutes to review various museum documents and then asked to write a letter to museum patrons that highlights the upcoming schedule of museum exhibits and activities. These letters were rated on a scale taking into account grammar, punctuation, organization, and style. [Low score = 0, High score = 100]	High: 92 Low: 71
Polygraph Test Asked questions related to trustworthiness and ability to manage money	High: Passed all questions Low: Passed half of the questions
Personal Characteristics Marital status and number of children	High: Married with 2 children Low: Not Married
Most Recently Held Position Position the applicant currently holds	High: Curator at another museum Low: Asst. Curator at another museum
Location of Birth State or country in which applicant was born	High: California Low: Germany
Art Museum Work experience Number of years experience working in an Art museum	High: 4 years Low: 6months
Hobbies Activity that applicant enjoys doing in his/her spare time	High: Cooking Low: Cycling
Simulated Speech In an assessment center activity, applicants were given 15 minutes to prepare a 5-minute speech on how to increase the number of visitors to the museum. The speeches were rated using a series of benchmarks by a panel of trained judged. [Low = 0, High = 100]	High: 89 Low: 74

Appendix H

Information Search Decision Rules

Appendix J

Information Search Decision Rules

	Information Search Pattern	
	Attribute-wise	Alternative-wise
Compensatory		
Decision Rule	Linear	Additive Difference
Pattern Index	Positive	Negative
Variability	Low	Low
Noncompensatory		
Decision Rule	Conjunctive	Elimination by Aspects
Pattern Index	Positive	Negative
Variability	High	High

Note. From Weiss, R. J. (1996). The effect of response mode and affective state on multiattribute decision-making, Unpublished Masters Thesis, University of Nebraska at Omaha.