How Much Information Does An Expert Use?

Is It Relevant?

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Abstract

Many observers of expert decision makers have assumed an Information-Use Hypothesis: The amount of information used, as measured by number of significant cues, should be greater for experts than non-experts. Since prior studies consistently have shown that both expert and naive judgment can be described using few cues, the conclusion has been drawn that experts are limited decision makers. This paper takes a new look at this conclusion by reviewing recent literature on information use of experts and by presenting some new evidence. The results from five studies show that experts often have the same (or fewer) number of significant cues as novices, but that the information used is more relevant. Therefore, the amount of information used does not reflect degree of expertise; however, the type of information used does. This finding has implications for measurement of expertise, analysis of expert tasks, and generalizability of conclusions about experts.

Introduction

Most observers of judgment and decision making accept the following two-part argument: First, to make effective decisions, all cues which are diagnostic or predictive of the outcome should be included in a decision. In complex real-world environments, there will be numerous sources of diagnostic information. It follows that experts should base their judgments on many cues.[1]

Second, most decision makers use simplifying heuristics when making judgments (Tversky & Kahneman, 1974). This leads to reliance on less than optimal amounts and inappropriate sources of information. That means decision makers generally base their judgments on a small number of cues, often used suboptimally.

The assumption that experts should use more information than non-experts is labeled here the Information-Use Hypothesis. This implies that information use should reflect degree of expertise. Using a judgment or policy analysis (Anderson, 1981; Hammond, McClelland, & Mumpower, 1980; Hoffman, Slovic, & Rorer, 1968), a researcher can determine the number of significant cues in a subject's judgments. Greater cue usage would then imply greater expertise and lesser cue usage would imply less expertise.

The evidence, however, is that judgments of both experts and non-experts can be described by a small number of significant cues. "A robust finding in research on human judgment is that relatively few cues account for virtually all of the systematic variance" (Reilly & Doherty, 1989, p. 123). Since there is little evidence of greater information use by experts, the conclusion is that experts often are limited in the same way as naive decision makers (Goldberg, 1968).

Not only do experts make use of little information, the evidence suggests their judgments can be described by simple linear models. Despite extensive efforts to find nonlinear (configural) cue utilization (e.g., Hoffman, Slovic, & Rorer, 1968), almost all the variance in judgments can be accounted for by a linear combination of cues (Goldberg, 1968). "The judgments of even the most seemingly configural clinicians can often be estimated with good precision by a linear model" (Wiggins & Hoffman, 1968, p. 77). As Dawes and Corrigan (1974, p. 105) conclude, "the whole trick is to decide

what variables to look at and then to know how to add."
Consequently, expert judgments often lack the complexity expected from superior decision makers, either in the number of significant cues or in the model used to describe their judgments. These findings paint a picture of experts making judgments in much the same way as naive subjects, with little evidence of any special abilities (Kahneman, 1991).

The purpose of this paper is to explore information use by experts. The research question is: What relation exists, if any, between the amount of information used and expertise? This question will be addressed by reviewing previous literature and by presenting results from five recent studies comparing information use by experts and novices.[2]

Review of Literature

Research findings consistently have shown that the judgments of experts can be described by fewer significant cues than expected. For instance, Hoffman, Slovic, and Rorer (1968) reported that medical radiologists had two to six cues in their judgments; in a similar study, Einhorn (1974) found that medical pathologists had 1 to 4 significant cues. Stockbrokers were found to rely on six to seven cues (Slovic, 1969). Clinical psychologists rely only part of the relevant information (Goldberg, 1968) and are insensitive to increases in the amount information available (Oskamp, 1965). And analyses of grain judges showed they were not using all pertinent cues in grading corn (Hughes, 1917; Wallace, 1923) and wheat (Trumbo, Adams, Milner, & Schipper, 1962).

In these studies, analyses of experts produced a small number of significant cues.[3] Yet in each case, more (often much more) information was available. This suggests that experts may make important decisions without adequate attention to the complete set of cues. If so, then it should not be surprising to find that expert decisions often are seriously flawed (Dawes, 1988).

The amount of information used has been applied to evaluate the appropriateness of various research paradigms. For instance, Ebbesen and Konecni (1975) compared the number of cues used by court judges when setting bail in both a simulated and a live court setting. Their results showed that most of the available information was used in simulated study while only one cue was used in the live courtroom. The authors felt the courtroom results were more valid because the setting was more natural. They argued that laboratory decision tasks lack external validity. Thus, the amount (and type) of information used by experts may be misestimated in traditional tasks.

With a similar approach, Phelps and Shanteau (1978) asked, "How much information can an expert use?" Using judgments of gilts (female breeding pigs) by livestock judges, the paper showed that two research methods lead to different answers to the question. In the first, judgments were based on photographs of Poland-China gilts. In the second, judgments were made of gilts described by verbal statements along 11 relevant dimensions. The judges were found to have 0 to 3 significant cues in the former, but 9 to 11 in the latter. These results were interpreted to show that intercorrelations present in naturalistic stimuli tend to reduce the number of cues found. The judges were capable of using considerably more information than revealed by standard methods.

Although the conclusions vary, these studies reflect the information-use hypothesis. In each case, the interpretation of the results

focused on how much information experts use to make their judgments.

Irrelevant Information

One possible explanation for the limited use of relevant information by experts is that they often are influenced by irrelevant cues. Clearly, experts should be selective and use only information which is the most relevant or diagnostic.[4] However, there is considerable evidence that irrelevant cues inappropriately influence the judgments of both naive and expert subjects. In a literature survey, Gaeth and Shanteau (1981) found over 250 published reports showing the effects of irrelevant information on psychological judgment.

Many of these studies report the impact of irrelevant cues in laboratory studies. In a Bayesian task, Troutman and Shanteau (1977) found that nondiagnostic samples influenced the probability revisions of subjects. Similarly, much of the research on heuristics and biases illustrates how normatively irrelevant factors such as representativeness (Kahneman & Tversky, 1972) and availability (Tversky & Kahneman, 1973) determine uncertainty judgments.

In an important series of studies, Doherty and colleagues explored the "pseudodiagnosticity effect." Subjects often use and even choose irrelevant information over relevant information when both are available (Doherty, Mynatt, Tweney, & Schiavo, 1979; Doherty, Schiavo, Tweney, & Mynatt, 1981).

Studies of real-world decisions show a similar pattern. Rice (1975) found that irrelevant biographical information influenced evaluations by school administrators. In a study of soil judges, Gaeth and Shanteau (1984) observed the influence of irrelevant materials on soil classification. For personnel hiring, Haefner (1977) reported that age (which is legally irrelevant) significantly influenced interviewers' assessments (also see Shanteau & Nagy, 1984).

Apparently, decision makers have difficulty ignoring information which is irrelevant for the task at hand. Then may explain, in part, why many studies find relatively few significant relevant cues. Through a "dilution effect" (Shanteau, 1975), subjects may be watering down their judgments by attending to extraneous sources of information.[5]

Evidence on Information Use

Five recent studies provide a new look at how much information experts use. In these studies, the amount of information used by mid-level novices was compared to experts in professionally challenging tasks. In each study, the qualifications of the "experts" appear unquestionable. These studies provide an opportunity to reexamine the information-use hypothesis.

Ettenson, Shanteau, and Krogstad (1987) asked 21 professional auditors (10 partners and 11 managers) to evaluate the materiality of a proposed account adjustment for 16 cases. For comparison, 11 accounting students did the same task. Analyses showed 3.3 cues significant (out of 8) for partners, 2.7 cues for managers, and 2.6 cues for students; the difference between the three groups was not significant. However, the pattern of cue weights was different with professionals primarily relying on one cue, as opposed to a broad spread of cue weights by students. Therefore, the numbers of significant cues did not differentiate between experts and novices, but the pattern of cue weights did.

In a study of medical diagnosis, Hammond, Frederick, Robillard, and Victor (1989)

compared two practicing physicians, three advanced medical students, and two pre-medical students on diagnoses of six pulmonary cases. Analyses of verbal protocols showed medical students gave more diagnostic statements (210) than either physicians (145) or pre-medical students (99). The types of statements differed, however; physicians were more balanced than students in considering different types of information.

Shanteau, Grier, Johnson, and Berner (1991) asked 24 third-year nursing students and 7 faculty nurses to rate the relevance of information in a nursing scenario. Nursing experts labeled 44% of 41 items as "essential" in making a nursing diagnosis. In contrast, student nurses labeled 67% of the items as essential. After taking a course on decision making and problem solving, students reduced the essential items to 50%; the quality of their decisions then improved. The student nurses behaved more like experts when they became more discriminating.

In an unpublished part of Phelps' (1977) dissertation, 4 livestock experts and 45 students studying to become livestock judges evaluated the breeding quality of a set of gilts (female pigs). Each gilt was described by 11 cues, 9 of which were relevant (eg, body weight) and 2 irrelevant (eg, tail curliness). The 16 gilts were specified by a fractional factorial design (Addelman, 1962) as used by Phelps and Shanteau (1978).

Analyses of variance showed an average of 5.2 significant cues for experts. Comparable analyses for students revealed an average of 5.7 significant cues. Thus, the number of cues did not discriminate between levels of expertise. Further examination showed that experts, with one exception, ignored the irrelevant information. In contrast, 10% of the significant cues for students were irrelevant. It appears that experts and novices differed in their ability to discriminate between relevant and irrelevant information.

Bamber, Tubbs, Gaeth, and Ramsay (1991) compared 94 experienced senior auditors and 97 inexperienced staff auditors. Both groups were asked to review two audit cases and to revise their probability assessments after receiving two additional pieces of information. The added information was either relevant or irrelevant to the audit task.

Both groups of auditors responded with appropriate probability revisions when relevant information was presented. Irrelevant information produced a sizable shift for staff auditors' judgments (+3.1), but not for senior auditors' judgments (-1.2). In sum, inexperienced auditors were influenced by more information, because they did not ignore what was irrelevant.

The evidence from these studies is consistent: judgments of experts and mid-level novices are based on similar amounts of relevant information. Although the methods vary, the results consistently reveal novices use as much or more information as acknowledged experts.[5] Taken together, these studies do not support the information-use hypothesis. Where experts differ from novices is in <u>what</u> information is used, not <u>how much</u>.

Possible Explanations

There are four explanations that can account for these results. The first is that the "experts" in these studies are not really experts; if qualified experts had been used, then the Information-Use Hypothesis might apply. Although it is possible to fault any single study on this basis, it seems unlikely that all studies misclassified the subjects. Instead, experienced professionals in these studies show every evidence of being true experts.

The second possibility is that the tasks chosen were not representative of the problems faced by experts; the Information-Use Hypothesis might apply only to tasks familiar to professionals. Again, this could be a shortcoming in any single study, but it seems improbable that nonrepresentative tasks were picked for all. In research on experts, stimulus problems typically are selected in consultation with professional colleagues. There is no reason to suspect they would systematically choose atypical tasks.

A third possibility is that incorrect methods were used to measure the amount of information in experts' judgments; use of the "correct" measurement method might support the Information-Use Hypothesis. In the studies reported here, four techniques were used to measure information use: protocol analysis, multiple regression analysis, analysis of variance, and self-ratings by judges. Despite differences in measurement methods, comparable results were reported. Other methodological issues might be raised, but the studies seem varied enough to rule out any artifactual explanation.

The final and most compelling explanation for the results is simply that the Information-Use Hypothesis is wrong. Given the consistency of findings across studies; this is the most plausible account. In no case did experts have significantly more cues than novices. And in several studies, experts relied on fewer cues. The evidence suggests there is no connection between the amount of information used and expertise.

An Alternative View

Despite its appeal, the Information-Use Hypothesis did not hold. The number of significant cues did not reflect expertise. In the present studies, novices were able to incorporate as much or more information into their judgments as experts. Although experts obviously have the ability to access large amounts of information, their performance on any one task reflects only limited information use. Apparently what is acquired in moving from mid-level novice to high-level expert is not the ability to access more information. So what is it that distinguishes experts from non-experts?

What separates the expert from the novice, in my view, is the ability to discriminate what is diagnostic from what is not. Both experts and novices know how to recognize and make use of multiple sources of information. What novices lack is the experience or ability to separate relevant from irrelevant sources. Thus, it is the type of information used – relevant vs. irrelevant – that distinguishes between experts and others.

The problem for novices is that information diagnosticity is context dependent. What is relevant in one context may be irrelevant in another. Only a highly skilled judge can determine what is relevant in a given situation – precisely the skill that distinguishes experts from non-experts. Thus, it is the ability to evaluate task context that is central to expertise.

Discussion

This view has three implications for research on judgment and decision making: First, the assumption that experts should use more information than novices in making a decision is not correct. The number of significant cues does not reflect degree of expertise. As reported in the studies summarized here, mid-level and even entry-level subjects often have as many or more significant cues as experts. Indeed, there is evidence to suggest that novices may rely on too much information and that experts are better because they are more selective (Shanteau, 1991). Thus,

the information-use hypothesis is inappropriate.

Second, the crucial difference between mid-level and advanced expert is the ability to evaluate what information is relevant in a given context. The problem, however, is that analysis of context is difficult, even for experienced professionals (Howell & Dipboye, 1988). Nonetheless, top experts through insights gained from experience know which cues are relevant and which are not. An interesting question for future research is to determine how this experience is translated into the ability to distinguish relevant from irrelevant. One possibility pointed out by Neale and Northcraft (1989) in an organizational setting is that experience leads experts to develop a "strategic conceptualization" of how to make rational decisions.

Third, these arguments imply that efforts to analyze experts across domains are fruitless. The Information-Use Hypothesis reflects an effort to evaluate expertise generically without reference to specific decision contexts. As the studies cited here show, the hypothesis does not work. This illustrates that it is difficult, if not impossible, for decision researchers to draw generalizations about experts without reference to specific problem domains. In future discussions of experts, any conclusions should be verified in more than just one domain.

Concluding Comments

In my 1978 paper with Ruth Phelps on livestock judges, we asked, "How much information can an expert use?" However, my view now is that this is the wrong question to be asking about experts. Instead, researchers should ask, "How do experts know what kind of information to use?"

In their paper on linear models, Dawes and Corrigan (1974, p. 105) concluded that "the whole trick is to decide what variables to look at and to know how to add." Although this sounds simple, it can be quite difficult to accomplish.[6] In particular, deciding what variables to look at can take a lifetime of experience for an expert. Even then, many novices are never able to acquire the necessary skills.

Belief in the Information-Use Hypothesis has led many to conclude that because experts rely on few cues they are inferior decision makers. But by concentrating on number of significant cues, observers may have overlooked what makes experts special – their ability to evaluate what is relevant in specific contexts. It is the study of that skill, not the number of cues used, that should guide future research on experts.

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Footnotes

[1] The terms "cue," "dimension," "factor," and "attribute" have been used more-or-less interchangeably in the literature to refer to the source of information used by experts. To avoid confusion, the term "cue" will be used throughout this paper.

[2] In agreement with the distinction presented in Shanteau (1991), the following definitions are used in this paper: "Experts" are considered to be the best at what they do. "Novices" are intermediate in skill and are trying to become experts. "Naive" decision makers know little or nothing.

[3] Thomas Stewart (personal communication, 1991) has pointed out that knowing what information to ignore may be as important as knowing what to attend to. In that sense, assigning zero weight to irrelevant information is a proper use of information. Thus, a complete measure of the amount of information used would reflect both what experts decide to use and what they decide not to use. Such a measure has yet to be developed.

[4] Irrelevant information in this analysis refers to cues which are not diagnostic for the context under consideration; the cues may be relevant in other contexts. Thus, the problem for an expert is to distinguish between what is relevant in a particular context and what is not.

[5] This same trend appears in research by Reilly and Doherty (1989). They asked 40 senior accounting students looking for jobs to evaluate 160 job offers described by 19 cues. A reanalysis of their results showed an average of 5.1 cues were significant. In a comparison task reported by Reilly and Doherty (1988), 77 undergraduates evaluated 100 profiles of potential roommates described by 18 cues. A reanalysis revealed an average of 6.0 significant cues. Although the two groups performed different tasks, the results provide suggestive evidence that more skilled subjects did not use more information.

[6] Other concerns about using linear model to describe decision making were expressed by Anderson and Shanteau (1977). In particular, they questioned the appropriateness of relying on correlations to support linear models. When goodness-of-fit tests are used, non-linear model forms generally are superior.