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Uncertainty revisited: People and information in a world of unknowns

Abstract: Psychological uncertainty is established in LIS models, but epistemic and aleatory uncertainties remain absent. We critically review the concept of uncertainty in LIS and beyond. Presenting a new framework on uncertainty for LIS, we suggest new approaches to more fully address the uncertain world we and our subjects inhabit.

Résumé : L'incertitude psychologique est un modèle établi en science de l'information, mais l'incertitude épistémique et l'incertitude aléatoire demeurent absentes. La communication propose une revue critique du concept d'incertitude en science de l'information et dans d'autres disciplines. En présentant un nouveau cadre conceptuel relatif à l'incertitude en science de l'information, nous suggérons de nouvelles approches pour mieux aborder le monde incertain dans lequel nous et nos sujets habitons.

1. Introduction

Uncertainty is considered a "fundamental" yet "underrated" dimension of information science (Ingwersen, 1995, p. 148). Wilson called it the "the ghost at the feast...[W]e may assume that much (perhaps most?) information seeking and retrieval are occasioned by *uncertainty*...[F]rom the perspective of the user, it is *always* there" (1999, 265). Information is identified as a "stimulus that creates a change in one's level (degree) of uncertainty" (Krikelas, 1993, 18), resolving or reducing uncertainty (Case, 2007; Krikelas, 1993; Kuhlthau, 1993; 2004, Wilson, 2004). These quotes make clear the *nature* of uncertainty typically addressed within the study of information behaviour in LIS: as a discipline, we construe uncertainty as a psychological state triggered by an information need, and resolved, therefore, by appropriate information.

Uncertainty is, however, a multifaceted concept: it *can* refer to a psychological state (cognitive or emotional), but it also denotes a state of knowledge (specifically, a *lack* of knowledge), or a condition of the world (in which the future or outcome is undetermined). The final category can be further subdivided into probabilistic uncertainty (where the probabilities associated with potential outcomes are known) and what Ellsberg (1961) terms *ambiguity,* where the probabilities (and indeed, possibly even the potential outcomes) are themselves uncertain. The first type of uncertainty can be termed *psychological* uncertainty; the second, *epistemic* uncertainty; and the third, *aleatory* or *stochastic* uncertainty. Psychological uncertainty arises from (possibly presumed) epistemic or stochastic uncertainty: that is, we arrive in a state of psychological uncertainty because we lack (or think we lack) knowledge, or because we know (or think we know) that some future state in which we have an interest is undetermined.

Uncertainty presents a challenge to decision makers, and most individuals demonstrate some degree of preference to avoid or resolve psychological uncertainty. Dewey (1960, p. 8) offers a potential explanation for this tendency: "[I]t is not uncertainty per se which men dislike," writes John Dewey, "but the fact that uncertainty involves us in peril of evils" (Dewey, 1960, p. 8). When the source of psychological uncertainty is *epistemic*, information is the obvious response;

however, when psychological uncertainty has an aleatory or stochastic source, there is no easy or obvious resolution. If I'm uncertain about the population of Khatmandu, information will resolve that state; but only time will tell if I am going to win the lottery, and the best information about the probability of winning will only place accurate parameters on my uncertainty. As we complicate the notion of uncertainty, the role of information professionals becomes similarly complicated. This paper is an exploration of the varieties of uncertainty, and the range of ways in which information professionals might assist information seekers in dealing with uncertainty.

2. Frameworks of Uncertainty

In this section we identify the varieties of uncertainty and offer examples of each. We do not explore psychological uncertainty in detail here, since psychological uncertainty is the product of either epistemic or aleatory uncertainty. In Table 1, we identify the other types of uncertainty and offer examples of each for clarification.

Type of Uncertainty	State	Example
Epistemic (lack of information)	Lack of factual information	What is the population of Khatmandu?
Aleatory (world-based, probabilistic)	Outcome is uncertain	Will I win the lottery?
Aleatory (world-based, ambiguous)	Outcome is uncertain, probabilities are unknown, and possible outcomes may also be unspecified	What will be the impact of global warming?

Table 1: Types of Uncertainty

There are important differences between the two sub-types of aleatory uncertainty. In the case of probabilistic aleatory uncertainty, the potential outcomes are known as are the probabilities associated with them. The lottery is a prototypical example of this type of uncertainty: while it is impossible to know whether I will win the lottery, the possible outcomes can be specified, and an accurate probability can be attached to each outcome. The situation is quite different for ambiguous aleatory probabilities. In some cases, the outcomes are known but probabilities are not: when I choose a new paint colour from my room, I am certain that in the end I will either like the colour or I will not, but it is impossible to specify the likelihood of each of these outcomes. The situation is further complicated when neither outcomes nor (obviously) probabilities can be specified. If I want to predict the impact of global warming I find myself in exactly this situation, since I am entirely unsure of the range of possible outcomes, let alone the probability that each will occur.

3. Coping with Uncertainty

When faced with epistemic uncertainty, the typical information seeker will look for the information they need and thereby resolve their uncertainty. When faced with aleatory uncertainty, no such simple strategy is available; and yet we must operate in situations aleatory uncertainty all the time: Should I have a flu shot? Will buying a hybrid vehicle make a real difference to climate change? Which graduate school will be the best for me? Real world decisions such as these involve situations of aleatory uncertainty, and information seekers (and decision makers) must operate within this (sometimes uncomfortable) uncertainty. How do they cope?

The answer is, at least in part, by 'manufacturing' certainty or reducing complexity: applying biases in information processing that allow us to *feel* more certain when real-world uncertainty is unavoidable. Thus, for example, the *confirmation bias* (Nickerson, 1998), which leads individuals to selectively attend to information consistent with a prior or developing decision. In situations where the range of possible outcomes is unspecified, the *accessibility bias* (Iyengar, 1990) leads us to focus selectively on those that are most salient, for example because they have been most widely covered in the media. Because probability information is difficult to interpret, decision makers may focus on the nature of the outcomes, ignoring likelihood, leading low-probability outcomes to be over-weighted in the decision making context. The *status quo* bias (Samuelson, 1988) leads decision makers to over-value the current state of affairs, showing a potentially irrational preference for the status quo over other alternatives. These and other biases *may* lead to good decisions in the face of uncertainty; they do, however, represent departures from fully rational decision making, and can in at least some circumstances lead to sub-optimal outcomes.

In order to support users in navigating real-world uncertainties, information professionals should pay close attention to these and other cognitive strategies that users employ, often unwittingly, in the face of uncertainty. Optimal decision making models such as that developed by Yates and Tschirhart (2006) provide guidelines for the types of decision support that information professionals could be offering users. We should be exploring information presentations and displays that help users overcome natural biases such as the accessibility bias in order that they can more effectively interpret and use information *about* an uncertain world.

Conclusion

Historically, research in LIS deals with *epistemic* rather than *aleatory* uncertainty: lack of knowledge rather than indeterminacy. Under this perspective, uncertainty is effectively addressed by information. Information cannot, however, resolve world-based uncertainty: world-based uncertainty is irreducible. In the context of aleatory uncertainty, the goal cannot be uncertainty reduction. Instead, we should attempt to support information seekers by fostering reflection and strategies that permit optimal reasoning in the face of irreducible, and sometimes discomfiting, uncertainty.

References

Case, D.O. (2007). *Looking for information: A survey of research on information seeking, needs, and behavior*. Boston: Academic Press.

Dewey, J. (1960). *The quest for certainty.* New York: Putnam.

Ellsberg, D. (1961). Risk, ambiguity, and the Savage axioms. Quarterly Journal of Economics, 75, 643-669.

Ingwersen, P. (1995). Information and information science. *Encyclopedia of library and information science, 56*(s19), 137–174.

Iyengar, S. (1990). The accessibility bias in politics: Television news and public opinion. *International Journal of Public Opinion Research, 2(1),* 1-15.

Krikelas, J. (1983). Information-seeking behavior: Patterns and concepts. *Drexel library quarterly, 19,* 5-20.

Kuhlthau, C.C. (1993). A principle of uncertainty for information seeking. *The Journal of Documentation, 49*(4), 339-355.

Kuhlthau, C.C. (2004). *Seeking meaning: A process approach to library and information services*. Westport, Connecticut: Libraries Unlimited

Nickerson, R.J. (1998). Confirmation bias: A ubiquitous phenomenon in many guises. *Review of General Psychology, 2(1),* 175-220.

Samuelson, W. (1988). Status quo bias in decision making. *Journal of Risk and Uncertainty, 1(1),* 7-59.

Wilson, T.D. (1999). Models in information behaviour research. *Journal of Documentation, 55*(3), 249-270.

Wilson, T.D. (2000). Human information behavior. *Information Science Research, 3*(2), 49-55.

Yates, J.F. & Tschirhart, M.D. (2006) Decision-making expertise. In K.A. Ericsson, N. Charness, P.J. Feltovich, & R.R. Hoffman (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 421-437). New York: Cambridge University Press.