Putting Naturalistic Decision Making into the Adaptive Toolbox

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Naturalistic decision making (NDM) falls clearly within the realm of bounded rationality — the art of making decisions with limited time, knowledge, and other resources. Herbert Simon, known as the father of bounded rationality, once illustrated its logic with the image of a pair of scissors whose blades are cognitive heuristics and the structure of environments. The study of bounded rationality is accordingly the analysis of the heuristics people use, the analysis of the structures of environments in which people make decisions, and the match between the two. We have called the degree to which this match exists the 'ecological rationality' of a heuristic, that is, the degree to which it can exploit the structure of information in its environment (Gigerenzer *et al.*, 1999). There are strong parallels between our research program on ecological rationality and that of NDM, such as the focus in both on simple decision-making heuristics that are task-specific rather than general-purpose and computationally fast and frugal rather than optimizing. Work in NDM has already expanded our understanding of these components of the 'adaptive toolbox' of human decision mechanisms (Todd *et al.*, 2000). In this comment, we highlight how the ecological rationality perspective can help strengthen NDM research in turn.

NATURAL DECISION MAKING CAN BE FORMALLY MODELED

Perhaps the most important feature of NDM is that it deals with real-world tasks rather than with the stock-in-trade of classical decision experiments, such as choice between hypothetical gambles. Together with its focus on expertise and on group decision making, these aspects of NDM research have opened up promising areas of investigation. However, these emphases seem to lead NDM researchers to feel that they cannot build precise models of the decision-making processes involved in real-world situations. Lipshitz *et al.* (this issue) state that 'to be valid, NDM models have to describe what information decision makers actually seek, how they interpret it, and which decision rules they actually use. This is another reason why NDM models tend not to be formal, and especially not abstract.' We agree with the first sentence, and disagree wholeheartedly with the second, which sets up a misleading opposition. NDM researchers need not choose between formal modeling and descriptively valid and task-specific (rather than abstract) processes. By focusing on the rules that people use to search for information, stop their search, and make decisions based on the information found, precise models can be built of the mechanisms that underlie much of human decision making, as we have done in studying fast and frugal heuristics in the adaptive toolbox (Gigerenzer *et al.*, 1999). While NDM researchers also point to the importance of considering psychological processes that generate decisions (rather than focusing on the final outcomes themselves), they do not take this objective far enough — overcoming the false opposition between formal modeling and real-world decisions can lead to more of the rigor and depth they desire for their theories.

RULES FOR SEARCH AND STOPPING

Here is an example of the kinds of questions that formal modeling could lead to. For situation–action matching decision rules, we agree that the search for options is an important and often-overlooked aspect of choice, usually leading to options being considered sequentially. In common with the NDM approach, we think that such sequential search can often be performed in a fast and frugal way through Simon's notion of satisficing — setting an aspiration level through prior experience and using that aspiration level to stop search once a sufficiently good option has been encountered. In this way, options need never be compared, nor complex optimal-stopping calculations performed. But this overall framework must be filled in with more specific models of the search and stopping processes involved.

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To begin with, how is the aspiration level set in the first place? This occurs during the learning process through which a decision maker gains the necessary domain-specific expertise, but we should be able to say more specifically how past experiences alter the aspiration level that a given expert uses. Second, how are the various options compared to the aspiration level? This is where NDM's situation–action matching rules come into play, but the precise method by which the matching occurs, and the nature of the cues over which that matching is done, remains to be spelled out for various specific domains. This matching process should also be fast and frugal to fit into the overall approach of making good decisions under time pressure — for instance, cues (which typically also need to be searched for) need only be sought until some sufficient level of confidence in a match (or certainty of mismatch) has been achieved. Finally, how are the options themselves found? The NDM perspective indicates that they are generated by the decision maker in a way that yields highly feasible options first — but can more be specified about the process that does this, rather than relying on vague ideas that sound like 'availability'? Some possibilities that we have already explored in the context of searching for cues include checking them in order of their past record of success, or past use, or randomly (Gigerenzer *et al.*, 1999).

BENEFITS OF FORMAL MODELING

Thus, in contrast to what Lipshitz *et al.* propose, the alternatives for studying NDM are not context-free formal modeling versus context-bound informal modeling, as research on context-specific formal models of the contents of the adaptive toolbox has shown (Gigerenzer and Selten, 2001). The greater precision that comes from formal modeling will allow detection and repair of current inconsistencies in NDM, fixing those spots where its bounded rationality is overcome by traditional ideals of complete information integration. For instance, the STEP model's use of extensive information processing, in which '. . . stories are revised to incorporate all available information into the most complete and plausible account possible', could be replaced by a more realistic fast and frugal process. New clear and precise predictions will also become possible, rather than reliance on fuzzy constructs such as 'mental models' and 'typicality judgments'; in particular, greater precision can engender surprising predictions of the sort that can give the strongest support to NDM theories. And formal models will allow the creation of computer simulations not only of natural decision situations in which to test human behavior (as is already done by NDM researchers), but also of the decision mechanisms themselves, so that the details of the operation of these mechanisms and their mesh with the environment can be worked out. By bolstering the theoretical foundations of NDM in these ways, it will become clear exactly how the components of NDM fit into the adaptive toolbox of ecological rationality.

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Perspectives on Naturalistic Decision Making from Organizational Behavior

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Lipshitz, Klein, Orasanu, and Salas (this issue) do a commendable job of reviewing the findings and issues that are starting to emerge from what some researchers have called naturalistic decision making (NDM), a subdiscipline of the field of decision making. My brief comments on this work are offered with a view to enhancing the potential contribution of NDM to its primary objective, that of understanding how people make choices in important and familiar situations.

The most significant contribution so far of NDM to the study of decision making has been to direct the attention of researchers towards experienced decision makers working in the field. This focus has the potential to shed light on some of the most important and consequential of decisions while providing a fertile ground in the search for valid prescription and constructive application.

NDM is described as 'an attempt to understand how people make decisions in real world contexts that are meaningful and familiar to them', but the role of experience and knowledge in the making of real decisions is emphasized. More specifically, NDM attempts to describe the cognitive processes of skilled decision makers by focusing on their observed behavior. Because NDM is new and continues to evolve, there is a lack of clarity and perhaps even confusion in terms of the phenomena that constitute NDM. Of greater concern, however, is that the potential contribution of NDM is constrained by its narrow parameters. Cognitions are relevant to but are not synonymous with decision making. Decision making in 'the wild' is about much more than cognition. As well, a preoccupation with the role of cognitive processes in decision making and behavior is neither novel nor unique to NDM.

NDM would benefit greatly from a broadening of its horizons. For example, if NDM is about how people use their experience to make decisions in the field, how specifically does the field affect, shape, or constrain the cognitions of decision makers? Organizations, after all, exist in part to minimize and compensate for the bounded rationality of the people who inhabit them. To obtain a validated theory of naturalistic decision making, it is necessary to investigate both to what decision makers attend and respond as well as the features of the environment which influence them while engaged in these acts.

A primary impediment to the progress of NDM in my view is its concern for empirically based prescription. The result has in general been the development of models that are conceptually impoverished. NDM may illustrate the view that there is a potential conflict of interest between those who are trying to produce knowledge about decision making and those who aspire to advise decision makers. These activities are not necessarily complementary.

The irony about NDM's concern for prescription and application is revealed by the oft-cited phrase that there is nothing so practical as a good theory. Validated theories frequently provide excellent guidance for practice. The appropriate response to a concern about inadequate application from existing models, therefore, is not dust-bowl empiricism but better theory.

I also have the impression that NDM researchers are missing out on a lot of good research on decision making in organizational contexts that is being published in mainstream management journals. Given the number of articles on managerial cognition and teams that have appeared over the years in the management literature, it is easy to think about what many NDM researchers may be missing by not borrowing more extensively from this literature.

To illustrate how NDM's focus on empiricism at the expense of conceptualization has led to the absence of even cognitive variables that are theoretically relevant to how expertise influences decision making, and to illustrate the utility of searching other literatures for potential insights into NDM, consider the case of self-efficacy. Efficacy beliefs refer to people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances. Self-efficacy is concerned 'not with the skills one has but with the judgments of what one can do with

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The paper provides an overview of known heuristic techniques and different views on decisionmaking based on heuristics. We discuss heuristics of the â€œheuristics and biasesâ€ program introduced by Daniel Kahneman and Amos Tversky, and heuristics of the â€œfast and frugal heuristicsâ€ program developed by Gerd Gigerenzer and colleagues. We propose the idea that heuristics, being a natural instrument of human assessment, may be applied not only for the simplification of the decision process, but also in deliberate strategies without sufficiently reducing the complexity of a problem. In light of this, The Adaptive Decision-Maker Framework is an example of the I. Other heuristic models. Theory of Reasoned Action.Â Theories regarding judgement, decision making and choice generally fall into two categories: normative theories of cognition and descriptive theories of cognition. Normative theories are concerned with 'how we should or ought to reason, make judgements and take decision' (Over, 2004). Theories falling into this category include formal logic, probability theory, and decision theory. Descriptive theories set out to describe how people actually think when making decisions and have empirical evidence to support them. In a simulated stock market paradigm, the payoff structure of environments was varied, favoring either compensatory or noncompensatory decision strategies in terms of expected long-term payoff. In both experiments, the majority of participants were classified as using strategies that were adequate for the environment, supporting the notion of adaptive strategy selection.Â Decision making with the "adaptive toolbox": influence of environmental structure, intelligence, and working memory load. @article{Brder2003DecisionMW, title={Decision making with the "adaptive toolbox": influence of environmental structure, intelligence, and working memory load.}, author={A. Br{\"o}der}, journal={Journal of experimental psychology. Amajor contribution of the naturalistic decision. making (NDM) community has been to describe. how people actually make decisions in real-world.Â action and elaborate these into decision trees. Even. when they did compare options, they rarely emÂ Naturalistic Decision Making. Gary Klein, Klein Associates, Division of ARA, Fairborn, Ohio. Objective:This article describes the origins and contributions of the naturalistic decision. making (NDM) research approach. Background: NDM research emerged in the 1980s. and gives the following decision tree: Now, this answer to a similar question suggests the importance is calculated as. Where G is the node impurity, in this case the gini impurity. This is the impurity reduction as far as I understood it. However, for feature 1 this should be: This answer suggests the importance is weighted by the probability of reaching the node (which is approximated by the proportion of samples reaching that node). Again, for feature 1 this should be: Both formulas provide the wrong result.