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A naturalistic decision making perspective on studying intuitive decision making

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ABSTRACT

The Naturalistic Decision Making (NDM) community defines intuition as based on large numbers of patterns gained through experience, resulting in different forms of tacit knowledge. This view contrasts with Fast and Frugal Heuristics (FFH) researchers, who view intuition in terms of general purpose heuristics. The NDM view also differs from the Heuristics and Biases (HB) community, which sees intuitions as a source of bias and error. Seven suggestions are offered to assist the FFH and H&B communities in improving intuitive decision making and in conducting research that has greater potential for application.

Rather than trying to help people analyze which option to choose, the NDM community recommends that intuitions be strengthened by providing a broader experience base that lets people build better tacit knowledge, such as perceptual skills and richer mental models, as a means of achieving better decisions.

The field of Naturalistic Decision Making (NDM) was started in 1989 to understand how people make decisions in applied, as opposed to artificial laboratory settings (Klein & Hoffman, 2008). NDM researchers (e.g., Klein, Calderwood, & Clinton-Cirocco, 2010; Klein, Orasanu, Calderwood, & Zsambok, 1993) discovered that decision makers in natural settings relied heavily on intuition; the researchers subsequently searched for ways to strengthen intuitive decision making (Klein, 2004). Therefore, one of the goals of this special issue, helping practitioners and theorists alike in their endeavor to strengthen intuition in organizational decision making, is highly compatible with the NDM enterprise.

My intent in this article is to offer the Fast and Frugal Heuristics (FFH) community and the Heuristics and Biases (H&B) community several suggestions that might be useful for achieving the goal of strengthening intuition. (See also Shan & Yang, in preparation, who have examined parallels and disconnects between NDM and FFH, and explored the potential for fusion of these two perspectives.)

However, it might also be useful to clear away some possible terminological tangles. Dialog can be difficult when we use the same words in different ways, and believe that we are communicating effectively. Terms such as intuition, expertise, and decision making have somewhat different meanings for NDM, FFH, and H&B researchers.

What is meant by "intuition"? The FFH community views heuristics as a basis for intuition, and sees both in a positive light (e.g., Gigerenzer, 2007; Gigerenzer, Todd, & The ABC Research Group, 1999; Hertwig, Hoffrage, & The ABC Research Group, 2013). These heuristics and intuitions can be applied rapidly to yield decisions that are almost as good as the choices obtained through laborious analysis using algorithmic methods. Novices can take advantage of these heuristics/intuitions. Heuristics can arise from individual learning, from social learning, and from phylogenetic learning (Gigerenzer, Hoffrage, & Goldstein, 2008), and result in general purpose tools such as Take The Best, the Recognition Heuristic, and the others found in the adaptive toolbox.

In contrast, the NDM community views intuition as an expression of experience as people build up patterns that enable them to rapidly size up situations and make rapid decisions without having to compare options (Klein, 1998; Klein et al., 2010). This view of intuition seems to fit with the Chase and Simon (1973) claim that experts need to acquire thousands of patterns (see also Shanteau, 2015). These patterns are not generic tools. They are specific accumulations of direct and vicarious experiences.

Therefore, the concept of intuition is different for the FFH community than the NDM community. The FFH perspective on intuition comes into play when the heuristics match the underlying statistical features of the situation. The NDM view comes into play when decision makers are sufficiently experienced to rely on the patterns they have learned. Of course, some decision makers will learn more from the same experiences than others. But experience seems

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to enable most people to handle challenging decision points with reasonable levels of success.

Suggestion: The FFH community might consider expanding beyond generic heuristics to include pattern-matching processes. For example, Garcia-Retamero and Dhami (2009) showed that two types of experts, experienced burglars and experienced police officers, used the same heuristic, take-the-best, in judging whether a residence was worth burgling; novices used a different strategy, a weighted additive linear strategy.[1] This study was a fine application of the FFH perspective. However, an NDM perspective would have probed more deeply into the differences in cues used by the burglars and the police officers. The burglars relied on presence/absence of an alarm system but the police relied on easy access via ground-floor doors and windows. An NDM study would have examined the ways that these judgments were made. These comments are not intended as criticisms of the study—after all, who can resist a study of professional burglars? Rather, the comments are intended to contrast the FFH and NDM approaches.

Ease of access to a residence may be more complicated than doors and windows on the ground floor. And this raises the issue of perceptual skills and tacit knowledge. For NDM researchers, intuition depends heavily on tacit knowledge.

Suggestion: The FFH community might consider broadening beyond explicit cues (e.g., presence/absence of an alarm system) and finding ways to incorporate tacit knowledge into the picture. Access to a residence might include factors like visibility (presence of bushes and trees to mask entry), type of window and ease of getting through, having a window slightly ajar on the second floor within easy reach if the burglar is sufficiently tall and athletic. So issues of affordances enter into the assessment. Assessments are not only about cues; they are also about capabilities, and the intersection of cues and capabilities. These are the kinds of issues that FFH might consider examining in future work.

What counts as expertise? For FFH, expertise depends on calibration with the cue structure in the environment. NDM researchers identify experts as having rich repertoires of patterns, being able to make fine discriminations that may be invisible to novices, having sophisticated mental models of how things work, and having resilience to adapt to complex and dynamic situations. The FFH and NDM views of expertise are not incompatible.

Suggestion: The FFH community might explore more facets of expertise.

Are intuitions valuable? The FFH and NDM communities both would answer in the affirmative, although they differ in what they mean by intuitions. Both the FFH and NDM communities part ways with the H&B view of intuition as a source of biases and errors. (Intuition overlaps with the concept of System 1 thinking, but is not identical to it.) The value of the H&B perspective has been well demonstrated in applications such as behavioral engineering, and the H&B researchers provide a useful service in promoting skepticism about undocumented claims for intuitive judgments. The H&B view (Tversky & Kahneman, 1974) holds best when the conditions do not exist for achieving expertise—the environment is too chaotic and unpredictable and/or there is little opportunity to learn from feedback. Not all experiences support the development of expertise. Kahneman and Klein (2009) and Hogarth (2001) have argued that intuition can only be trusted if it reflects repeated experience in environments with reliable feedback. Intuition does not require the kind of precise repetitions needed to obtain automaticity; it requires sufficient repetition to synthesize patterns and prototypes.

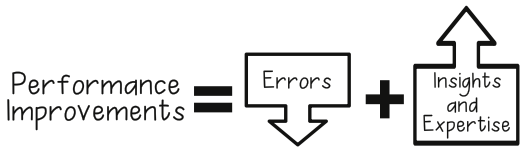

Fig. 1. Conditions for improving performance.

The H&B approach to intuition is generally to straitjacket it by monitoring it carefully with System 2 analyses. Hogarth (2001) has suggested that through a program of instruction the scientific method could be somehow become intuitive, a suggestion that is at variance with the NDM notion of intuition as the accumulation of experiences.

My concern with the H&B position on the value of intuition is that (a) it primarily draws from research with naive participants and fails to reflect the advantages of experience; (b) it usually seeks to debunk experts rather than to understand their advantages over novices; (c) it is highly sensitive to errors and does not properly value the benefits of insights and expertise.[2]

Klein (2013) provides a formulation for improving performance, shown in Fig. 1. Performance improvements depend on both reducing errors and increasing insights and expertise. I believe that the H&B community takes an imbalanced interest in the former—in ways to reduce errors. It shows little interest in the benefits of heuristics, and in the value of expertise and insights.

Suggestion: The H&B community might look for ways to broaden their investigation from the left-hand downward arrow, reducing errors, and consider the conditions under which the right-hand arrow, increasing insights and expertise, might come into play. The H&B community might benefit from exploring the positive aspects of expertise, and from investigating conditions under which an excessive effort to reduce errors and activate System 2 might be counter-productive.

What is meant by decision making? This question seems simple enough—decisions are choices from among several options. The decision maker evaluates the options and selects one of them.

Hoffman and Yates (2005), however, have described the limitations of thinking that we "make" decisions culminating in a commitment to action. Hoffman and Yates adopt the concept of a decision as "a commitment to a course of action that is intended to yield results that are satisfying for specified individuals" (Yates & Tschirhart, 2006, p. 422). They list a set of cardinal issues surrounding the process of deciding. These include determining the set of goals and needs; managing the costs of deciding; scanning the options; envisioning nonobvious consequences; conducting tradeoffs; anticipating impediments to implementation. These different issues will require different types of support.

Suggestion: Broaden the concept of decision making beyond the evaluation and selection of an option.

My own research suggests that people with experience rarely engage in the process of choosing among several options. Using their intuition, the patterns they have acquired, they usually identify an effective option as the first one they consider, based on the pattern-recognition process (Klein et al., 2010; Klein, Wolf, Militello, & Zsambok, 1995). Pattern matching generates an action queue of plausible responses, options, to be considered, starting with the most plausible. Therefore, experienced personnel often adopt the first course of action they consider. We still consider this behavior "decision making" because people encounter decision points—places where other plausible options existed. They just do not consciously examine these options, and we believe they do not

[1] In a study with airport custom officers as experts and a novice control group, Pachur and Marinello (2013) obtained basically the same pattern: The majority of the experts were best described by the take-the-best heuristic, whereas the majority of the novices were best described by an additive strategy.

[2] I am distinguishing between intuition and insights. Intuition depends on the patterns a person has acquired; insight is a means of generating new patterns.

subconsciously examine them either. The pattern-matching short-circuits option generation and comparison. The FFH community has considered a range of heuristics that have this feature.

Going back to a common definition of a decision as a choice from among several options, if one option stands out as exciting and the others have clear flaws, then people do not need much assistance. Now if we move the options closer together so that their strengths and weaknesses balance out, then the choice becomes much more difficult but the consequences vanish. This phenomenon was described by Minsky (1986) as Fredkin's paradox, and in the Judgment and Decision Making literature as a flat maximum (Von Winterfeldt & Edwards, 1973). If the strengths and disadvantages of the alternative courses of action balance out, then it does not matter much which option we select. Thus, in most cases people will not benefit from decision supports.

The data suggest that people rarely express a need for decision supports. Yates, Veinott, and Patalano (2003) found that undergraduate students were very satisfied with their decision making.

Suggestion: Be cautious in advocating for types of decision supports that work well under controlled conditions but may be less beneficial in natural settings. For example, Bayesian statistical techniques that work well on isolated problems may not apply to dynamic, interactive and highly contextual tasks (Lopes, 1991; Lopes & Oden, 1991). Methods that work in principle and in pristine conditions need a great deal of ruggedization before they will tempt organizational decision makers—the customers for intuitive decision making supports.

Let us try this thought experiment. Imagine that a researcher developed a pill that improved intuitive decision making. It worked spectacularly in laboratory tests. Now the researcher would want to market it. But wait, the Food and Drug Administration (FDA) would ask for more testing. The researcher would need to try it out in field conditions. The FDA would want to know how easy it would be to follow the prescribed regimen. It would ask what would happen to the effectiveness if someone failed to follow the protocol exactly. It would want to determine the pill's effectiveness with all kinds of sub-groups. Just having a pill that scores well in trials is necessary in order to start the approval process, but certainly not sufficient to end it.

Suggestion: When developing new intuitive decision support methods, researchers should perform studies showing that people in organizational settings have a need and also a desire for improvement.

1. NDM approaches to strengthening intuition

This section illustrates some ways that an NDM perspective would try to improve intuition. For example, my research (Klein, 1998) suggests that experienced decision makers rely on pattern retrieval and pattern matching to determine an option to pursue. Their challenge is not choosing between alternative options but making sense of the events and conditions. They need help with situation awareness (Endsley, 1995) and sensemaking (Weick, 1995). They readily acknowledge this need and seem motivated to take steps to obtain that help. In this formulation, one result of accelerating decision makers' expertise by providing more informative experiences will be to produce better intuitive decision making (Hoffman, Feltovich, Fiore, Klein, & Ziebell, 2009; Hoffman & Militello, 2009; Hoffman et al., 2013; Klein, 2004).

1.1. Intuitions and tacit knowledge

Expertise primarily consists of tacit knowledge, rather than explicit knowledge of facts and similar forms of declarative knowledge (Polanyi, 1958; Polanyi, 1967). What differentiates the skilled decision makers my colleagues and I have studied is their ability to make perceptual discriminations, to recognize patterns, to draw on rich mental models, and to judge typicality (Klein, 2009). These aspects of tacit knowledge are, by definition, tacit—difficult to articulate and often unavailable to consciousness. Judgments and decisions based on these types of tacit knowledge will, therefore, appear to be intuitive. In this NDM perspective, strengthening intuitions means building experiences that result in more accurate and comprehensive tacit knowledge. Strengthening intuition means accelerating expertise. As Kahneman and Klein (2009) stated, "a psychology of judgment and decision making that ignores intuitive skill is seriously blinkered" (p. 525).

Of course, experience does not automatically translate into expertise, and we should be careful to distinguish between the two. Further, there is no shortage of self-proclaimed experts who are confident in their abilities and can convince others of these abilities, but who do not perform better than chance (see Shanteau, 2015). I am not claiming that experts are infallible—in fact, one indicator of whether someone is an expert is whether that person is mulling over his/her last error.

1.2. Acquiring tacit knowledge

Nonaka and Takeuchi (1995); von Krogh, Ichijo, and Nonaka (2000) have written extensively about the importance of tacit knowledge for organizations, and about methods for gaining tacit knowledge (see also Leonard & Swap, 2005). This body of work is probably the leading source of guidance on the topic of acquiring tacit knowledge. In this section I will add a little to this material by describing several of my own experiences in trying to foster tacit knowledge.

One approach involved the use of Tactical Decision Games (TDGs) (Schmitt, 1994) for helping military personnel become better decision makers. TDGs are short paper-and-pencil scenarios that describe a situation and the resources available to the decision maker, plus the mission, and then introduce an unexpected and challenging twist requiring a rapid decision. TDGs are often presented in small groups, and after announcing the unexpected twist, the facilitator typically calls on a group member to make a decision with little time to think or analyze, just as s/he will have to in combat. Part of the rationale is to prepare warfighters for uncertainty and time pressure.

However, in working with TDGs over a few years, I noticed that the scenarios that seemed richest and most effective were created by people with domain experience. Their scenarios included tough decisions, but also depended on seeing the affordances in the situation—for the military that might mean innovative ways of using terrain or equipment. I speculate that the critical learning was about the affordances; the decision challenge was the candy-coating that kept people interested and engaged. The affordances were about how things worked and how to rejigger them to make them work more effectively.

A second approach linked TDGs to military doctrine. In one project, we were trying to teach doctrine for tasks such as conducting an ambush or crossing a dangerous area. Doctrine is important because it represents best practices, and because you want everyone on your team to know the doctrine to reduce the chances of a coordination breakdown. Typically, doctrine is taught as declarative knowledge about a procedure—a description of a series of steps to follow. Learners are expected to memorize the steps. But our research team found a better way to teach doctrine by using TDGs and have the facilitator "punish" the wrong behaviors by introducing variations that would bring home the consequences of mistakes such as failing to post sentinels. The warfighters came to understand the reasons for the doctrinal methods. Only then would we explain that the doctrine was written down and give

them access to it. Thus, we started by building experience and by creating emotional reactions to decisions that violated doctrine.

A third approach used TDGs to teach structural relations. In yet another project, my team was collecting scenarios to turn into TDGs to teach safety issues to Navy pilots. We had 15–20 pilots in a class. One of the pilots described a night flight in which he lost all electrical power shortly after takeoff. Somehow he managed to navigate back to the aircraft carrier and land his plane safely. The class peppered him with questions about possible workarounds, techniques for rebooting the system, and other ideas. Often the questioner would ask about a possible tactic and then break off mid-sentence, muttering about how that really would not work because of the way the system was connected. By the end of the discussion, we all noticed that this scenario demanded detailed knowledge of the electrical system. The pilots agreed that they learned more about the system than when they were shown a wiring diagram and asked to memorize it. The TDG exercise – in this case merely a recollection of a scenario that could be turned into a TDG – yielded a functional understanding of the electrical sub-system and its interaction with hydraulics, communications, and other sub-systems. The tacit knowledge in this case was in the form of a richer mental model of the electrical system in action.

A fourth approach is to rely on actual workplace experiences to provide On-the-Job Learning. Fadde and Klein (2010) have described a number of On-the-Job Learning activities that have the potential to boost tacit knowledge. These include observing skilled decision makers as they performed difficult tasks; experimenting with different strategies; engaging in after-action reviews to diagnose the reasons for successes and failures; soliciting coaching from skilled decision makers.

A fifth approach uses a scenario-based method akin to Tactical Decision Games. Klein, Hintze, and Saab (2013) have described a ShadowBox method for having trainees address decisions in the midst of scenarios that are presented in paper-and-pencil format; one software version runs on a tablet computer and another software version is web-based and runs on laptops. Unlike TDGs, the ShadowBox method does not rely on a facilitator. Instead, a group of Subject-Matter Experts read through a scenario and then provide their responses and the rationale behind these responses. The trainees are given the same scenarios and are asked to fill out their responses and rationales at specific decision points. Once they have provided their responses and rationales, the trainees are shown the synthesized Subject-Matter Expert answers and asked to identify how their answers differed from those of the experts. The ShadowBox exercise lets the trainee see the situation through the eyes of experts. The trainees get to notice what the experts are noticing and thinking that is new and different—helping the trainees to expand their own mental models. The trainees do not have to agree with the experts, they simply need to try to anticipate how the experts are going to think. A recent evaluation found that trainees increased their match to the experts by 28% after only a few hours (Klein, Borders, Wright, & Newsome, 2015).

The five approaches described in this section illustrate how a Naturalistic Decision Making approach might try to build tacit knowledge. The approaches emphasize perceptual skills, mental models, and patterns acquired through experience and familiarity. Other researchers have offered similar ideas, even researchers who are not part of the NDM community. For example, Hogarth and Soyer (2015) advocate for providing simulated experiences to help people gain richer mental models and stronger intuitions about uncertainty and forecasts.

The objective of an NDM approach is to strengthen mental models and acquire new beliefs. Behavioral approaches tend to rely on repetitions to strengthen connections, to try to achieve automaticity, whereas NDM approaches seek to provide insights and shifts in mental models.

1.3. Unpacking mental models

From the NDM perspective, mental models are a person's beliefs about causal relationships. People usually cannot articulate all, or even most of these beliefs, nor can they articulate how the different causal relationships interact. Yet these beliefs determine how people do mental simulations of different courses of action, to see how they might play out. These beliefs determine whether an explanation for an event is judged to be plausible. Mental models help us understand events and anticipate possible future states and events.

How can we study a person's mental model? Klein and Hoffman (2008) suggest using Cognitive Task Analysis (CTA) methods (Crandall, Klein, & Hoffman, 2006; Hoffman & Militello, 2009), and directing the analysis at the kinds of relationships and concepts that a person has a mental model about. Thus, to examine spatial relationships we can ask the person to draw a map. To capture temporal relationships we could request that the person create a script. To capture organizational relationships the person could prepare a wiring diagram of the people in the organizational hierarchy. To get a picture of a person's conceptual understanding we could use a concept map (Novak & Cañas, 2006).

Yates et al. (2011) have demonstrated how it is possible to get inside someone's head to understand more about how the person makes decisions. Their research strategy centers around an important decision rather than examining expertise. In this study, the decision was whether to wear a seat belt. Some drivers reliably use seat belts, others do not. At least, that is what they report. Yates and his colleagues arranged for drivers to borrow a car that, unbeknownst to them, had been configured to monitor seat belt use. So Yates et al. did not have to rely on self-report; they had actual data. They classified the drivers into those who always wore seatbelts, sometimes or rarely wore them. Then they went further. Through interviews they distinguished drivers who had set a policy to use seatbelts at all times; 98% of them actually used seatbelts. Other drivers had a partial policy. Their seatbelt use depended on distance, speed, likely presence of police officers, and other factors. They held flawed beliefs such as estimating the chance for an accident as lower for short trips than long ones. They used seatbelts 67% of the time. A third group had no policy at all—they used seatbelts 90% of the time. Research like this provides insights into the policies people adopt plus the basis for these policies, and their impact on behavior. They also point the way for educational interventions.

2. Conclusions

The purpose of this opinion piece is to provide a Naturalistic Decision Making perspective on the topic of improving intuitive decision making. The NDM view differs from both the H&B and F&F views in several ways. NDM researchers give greater prominence to the role of experience; they study decision making in actual contexts as opposed to using laboratory tasks. NDM researchers are less interested in teaching decision strategies than in helping people gain experience more quickly and make sense of more complex situations by bringing to bear a richer and broader knowledge base and conceptual base for making intuitive judgments and decisions.

Conflict of interest statement

The author declares that he has no conflict of interests.

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