Applications for naturalistic decision-making.

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Editorial: Applications for Naturalistic Decision Making

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Abstract

This guest editorial introduces the special section of the Journal of Occupational and Organizational Psychology 'Applications of Naturalistic Decision Making.' Contributing to the aim of the special section to highlight applications of NDM research for the benefit of an international community of scholars who examine the psychological complexities of decision making, the editorial discusses different approaches to NDM research. It is suggested that the value of NDM research can be seen in its application to understanding expert cognition across a wide variety of professional doains. In addition to exploratory investigation, it includes: (a) rich descriptive studies; (b) field and lab simulations; (c) theoretical development; and (d) a plurality of methods to elicit, document and share expertise.

Keywords: Naturalistic Decision Making, sensemaking, situation awareness, expert reasoning, cognitive task analysis

Introduction

The evolution of the NDM research community has resulted in a thriving area of psychology which focuses upon how professionals use their cognitive skills to perform complex tasks within organizations. NDM is a self organising community of practice (Hoffman & Militello, 2008) currently celebrating 25 years of research. Methodological advances in accessing expertise have gained respect and validity with the professionals participating in this area of investigation and researchers have become more proficient in documenting their, often qualitative, tools for knowledge elicitation and representation. The range of organizational contexts include health, military, aviation, sport, complex engineering and high-reliability industrial setting, most often where risk and uncertainty pervade the organizational landscape.

NDM has been defined as the study of how people use their experience to make decisions in field (Zsambok & Klein, 1997) and "real world" settings. Key characteristics include: ill-structured problems; uncertain dynamic environments; shifting, ill-defined or competing goals; action/feedback loops; time stress; high stakes; multiple players; organizational goals and norms (Orasanu and Connolly 1993). Gore et al (2006) and Pliske and Klein, (2003) note that when defining NDM, Zsambok (1997) identified four criteria which contrast NDM to more traditional types of decision research: it is context rich; most usually includes experts; describes the decision strategies people use; and is most often concerned with the point of interest within the decision period, including pre-choice processes (for example, situation awareness). More recently Hoffman (2015) insightfully observes that NDM is concerned with how people make decisions in complex real world uncertain contexts that can require real time decisions in urgent situations with significant implications for errors. He also notes that whilst NDM research emerged in the 1980s with a

focus upon decision making, it has advanced to deal more broadly with the question of how cognition adapts to complexity. This has resulted in the revision of professional practice and process and has developed training that is focused upon decision requirements.

So why a special section now ? Social scientists have noted that research communities making an advance in knowledge often involves contestation, the welcoming of a pluralism of methods and ideas, and the willingness to see things differently. The NDM community for the past two decades has welcomed the theoretical development and examination of *informed insight* and *intuitive expertise,* areas of cognitive psychology which are very rarely discussed by JOOP or mainstream decision psychology. Times however, have changed - perhaps it takes at least two decades to convince different communities of practice that a new mode of inquiry can complement and develop our understanding of human decision making ? Khaneman and Klein's (2009), *American Psychologist* paper, 'Conditions for intuitive expertise: A failure to disagree', has laid some questions about different ways of conceptualising decision making to rest and also acknowledged that communities of scholars and practitioners from different decision research traditions still have much to offer each other in order to develop a considered decision science research agenda. Thus, Kahneman and Klein (2009) agree that NDM demystifies and unpacks intuition (Gore & Sadler-Smith, 2011) by identifying the contextual cues experts use to make their judgments. NDM inquiry has taken a `second path' distinct from that taken by Tversky and Kahnemen (1974), which has led to the identification of a wide range of heuristics and biases. The second path, which the NDM movement adopts, is the close examination of skilled performance and expertise in order to elicit how the more powerful heuristics and decision requirements operate.

We offer in this special section insights into the development of the NDM community by providing illustrations of work which we hope will encourage other occupational and organizational psychologists to investigate NDM as an alternative or complementary avenue of cognitive inquiry. As editors, our NDM experience includes over two decades of research in this field and whilst we recognise that the frameworks, models and methods we use have their limitations, we remain enthusiastic about the questions and insights our community has to offer.

First we provide a brief historical overview of NDM research for scholars new to this area and second, we highlight the diversity of methodological techniques used by NDM researchers in relation to this special section.

Origins and evolution of NDM research

The first proponent of the naturalistic decision making approach was Gary Klein, who has continued to have an enduring and inspiring influence on the field. His background was in cognitive psychology but as he embarked on real world investigations of decision making by practitioners in high risk domains, he recognised the limitations of the methods and theories derived from conventional laboratory research. His field studies of fire commanders in the 1980s, sponsored by the US Army Research Institute, were based on post-event interviews. He recounts how his early attempts to fit their responses into traditional analytical choice models of decision making were notably unsuccessful. In essence, the commanders were describing a different cognitive process. Klein was sufficiently receptive to realise that their recollections of cognition during command were in fact more akin to intuitive decisions, founded on recognition, pattern matching and the recall of learned response patterns. Hence his recognition-primed model of decision making was devised. (See Klein, 2010 for an updated version of his original paper, in a special

issue, celebrating 20 years of NDM research). Another key figure, who has significantly influenced the direction and scientific rigour of NDM research endeavours is Judith Orasanu. Her series of elegant research studies at NASA has furthered the science of aviation decision making and our understanding of related crew behaviours (Orasanu, 2005). She was one of the sponsors of Klein's original work and also supported the first NDM conference in Dayton, Ohio in 1989, co-editing the resulting volume (Klein, Orasanu, Calderwood & Zsambok, 1993). This first meeting revealed just how many researchers were striving to analyse on-task cognitive processes of experienced workers, ranging from military officers to pilots to control room operators. Their accounts of field studies, cognitive task analysis techniques with applications for design and training, all with fundamental naturalistic principles, generated considerable interest in both academic and practitioner communities. Thus the NDM movement was launched and a series of biennial conferences (and associated books) followed, alternating between European and North American hosts (for example: Flin et al, 1997; Hoffmann, 2007). As many of the proponents were already members of the Human Factors and Ergonomics Society, a Cognitive Engineering and Decision Making Technical Group was established to serve HFES members who shared an interest in human cognition and decision making in complex real-world tasks. It rapidly became the largest specialist group within HFES.

Research from the NDM field is published in a range of journals, with the *Journal of Cognitive Engineering and Decision Making* as a principal outlet of empirical findings and theoretical argument (see the special issues on 20 years of NDM, Flin & Militello, 2010, and on situation awareness, 2015). Special issues on NDM have appeared in theoretical journals (Stanton et al, 2011) as well as applied journals

(Stanton & Wong, 2010). As previously noted, an over-rehearsed debate between NDM and more traditional decision researchers (Lipshitz et al, 2001) in the special NDM issue of the *Journal of Behavioural Decision Making*) has somewhat waned due to a decrease in conceptual polarity in recent years (Kahneman & Klein, 2009).

The Special Section

The call for papers resulted in the submission of high quality manuscripts that were subject to *JOOP's* normal review process. We were curious to see how far NDM ideas have spread around the globe and were also very interested in sharing applications of good practitioner papers which have resulted in new insights into the way experts and professionals complete their work. Thus our additional criterion was to ensure that we included work which we thought would inspire researchers who are new to NDM, to explore this area further. As summarised in table 1, each of the seven articles selected presents ideas that contribute to our understanding of human decision making from a wide variety of contexts including: the military, police, health, emergency services, shipping, sport and legal labour disputes, from the UK, USA, France, and Norway, utilising a diversity of theory, methods and analysis.

Insert Table 1 about here

Methodological strengths & limitations of NDM techniques and practitioner-based enquiry

In this special section we present a variety of studies in very different naturalistic settings. Several of these papers that we would consider normally

associated with the NDM paradigm, and others are opening new ways of thinking about what constitute NDM problems and cognitive adaptation to complexity. In the more predominant NDM situations, we see the more traditional methods of cognitive task analysis (CTA) being used. First, Klein and his team provide new insights into understanding why some police officers and military personnel are more effective at handling civilian interactions without creating hostility. The use of job shadowing combined with cognitive task analysis interviews (CTA) (Klein, et al, 1989; Crandall et al, 2006; Hoffman & Militello, 2008; Militello et al 2010) which used the Critical Decision Method (CDM), a retrospective technique which provides insights into critical incidents by eliciting and documenting different types of social and cognitive expertise. This work provides a good example of how researchers can work in situ to obtain rich data and a domain specific, theoretically informed sense making frame (termed here as "Good strangers") which can aid training and future ways of effective working in sensitive and conflict-ridden environments.

A second rich example of how to best use CTA techniques in context is provided by Militello et al whose work provides an important guide for designing information technology to be used in extreme environments. Employing a multi-method approach, they demonstrate the techniques used which are similar to those used in most traditional NDM studies. NDM work often includes and informs the design /information technology interface and aims to ensure socio-technological competence. Here Militello's team provide a practitioner case illustration of military pararescue jumpers employed by the United States Air Force. The jumpers are military personnel whose expertise lies in administering life-saving medical treatment in very diverse environments. In such a challenging design space, this NDM project has informed participants how to identify potential pitfalls associated with the

introduction of information technology for an extreme environment. Retrospective in nature, their CDM and Knowledge Audit were used to elicit mission expertise that was to be used in the design of new computer decision aids for the jumpers. The results from the 16 interviews were collated into Decision Requirements Tables, focusing on decision requirements, key information considered, strategies used, and elements of the situation that make the task particularly challenging. Militello and her team completed a staged world exercise and functional analysis providing a pragmatic fit which has relevance, workability and modifiability; key components of validity (Strauss & Corbin, 1998).

Field studies in naturalistic settings have been another familiar approach among the NDM community. In their study of bridge operations on Platform Supply Vessels (PSV's), Sandhåland and her colleagues used an ethnographic approach informed by an analytic perspective of situation awareness (SA), which attempted to identify and understand the antecedents of SA errors. The authors spent a year on board four PSVs collecting approximately 450 hours of observation data of bridge operations, focusing on the cognitive activities of planning, communication and the management of distracting and interacting elements.

Another difficult challenge is the study of the decision making that occurs within and across different emergency services during a major incident. Alison and his colleagues applied the concept of decision inertia - the cognitive processes associated with failures to execute action when a decision maker struggles to choose between equally perceived aversive outcomes . The response and recovery phases from a sudden impact disaster, during a two day immersive simulated emergency response, involving 14 agencies and 194 participants, were studied. The data collection was carried out while the emergency services were running an exercise

using the HYDRA multi-media immersive simulated learning environment. This is a simulation training method that has been adopted by many emergency services in the UK, and is often used in place of the traditional table-top exercise. Alison and his colleagues combined qualitative and quantitative methods to analyse the recorded communications between personnel.

In the healthcare domain, when patients fall while in care at a hospital, their conditions can deteriorate or lead to complications. In the study reported by Reiter-Palmon and her colleagues, they investigated the use of a debriefing or after-action review technique to identify errors or shortcomings in organizational procedures and decision making immediately following a patient fall. This technique is referred to as referred to as the "Post Fall Huddle". The method employed is a survey instrument called the "Post Fall Huddle Documentation" report that include prompts for information about different types of errors. For over a year, this report was used to collect data from 226 patient falls from 17 hospitals to discover the errors and mistakes that occurred, and in particular what types of errors may have contributed to a patient's fall. One of the problems faced by the researchers in this study was that nurses, doctors and other healthcare professionals associated with the patient who had fallen, are on different shifts and teams, and only come together for that moment and then disperse again to resume their duties and other assignments. Also, as the falls are infrequent and un-predictable and there is a need to document the fall promptly with the different staff participating. The method reported in this paper, the Post Fall Huddle Documentation, is a simple non-intrusive method that highlights key decision requirements and has been adapted well to operational conditions.

In a nascent area of NDM and sport, Macquet and Skalej were interested in understanding the time management strategies of elite athletes. This is illustrative of

how cognition adapts more broadly to complexity. The athletes must balance their academic studies with the demands of the physical training. The in-depth qualitative study of 12 student athletes, 6 in their first year of study, and 6 in their third year, used a retrospective interview method, through an RPD lens. Participants were asked to describe and comment on their how they use the time in their day, on circumstances, adaptations made to their plans, adjustments over the day or week, and the effect of time periods imposed by the organization and by their personal out-of-training activities. The interviews were recorded, transcribed and then analysed using the Constant Comparative Method. The method of retrospecting how the athletes' decide to use their time and how they plan and re-plan in the light of changing circumstances highlights cognitive complexity under conditions of fatigue and stress; the study introduces us to a community not usually considered when discussing NDM – elite sports participants.

Similarly another domain unfrequented by NDM researchers is industrial relations, and Ramiah and Banks introduce this new territory. Their methods provide insight into how arguments are used in resolving labour disputes, decisions which have significant consequences when mistakes are made under time-pressure. They suggest that whilst NDM has been very successful at describing fast, intuitive decision making by experts in complex, time pressured situations, less is known about how experts make naturalistic decisions when they think analytically. The authors studied the analytic reasoning process encountered in a different class of naturalistic problems - one involving the reasoning through of logical constraints in the context of realistic labour law problems. Although the cases addressed in the study were fabricated, and the conditions were controlled, the problems were realistic. Using a think aloud approach and a verbal protocol analysis, the data were coded against

Toulmin's 6-part model of arguments. A checklist of 6 questions corresponding to this model was developed as a decision aid to guide the analytic reasoning in resolving the labour dispute cases. 50 labour officers participated, 25 experts (who had prior experience of 890 cases) and 25 novices (with experience of 21 cases). Half of the group received this checklist / decision aid, and the other half did not. The results showed that when the logic constraints of the arguments are explicated, the labour officers were faster in resolving the disputes. Expert decision makers made more accurate, reasoned justifications (warrants).

We recognize that whilst in general the small numbers of participants involved in NDM investigations may be seen to be limiting by some research communities, we argue that our work provides rich and meaningful insights which can aid the design of training for novices in domain specific areas and provide ecological validity (Gore et al, 2006) which helps us to understand the complexities of human decision making at work. Put simply, NDM research has resulted in an improved contextual understanding of cognition and behavior, fuelled by a healthy curiosity about how to advance skill, competence and expertise.

Other emergent areas which require further investigation by NDM scholars include the importance of affect and expertise (Mosier & Fischer, 2010) and the exploration of new contexts and domains, such as intelligence analysis (Roth et al , 2010, Ormerod et al, 2014) and trading (McAndrew & Gore 2012), where decision problems are so new, drawing upon expertise is very challenging. We are also pleased to note that there are a growing number of researchers who recognize complexity and combine NDM methods with areas traditionally studied by behavioral decision researchers and those from the heuristics and biases tradition. We suggest therefore more nuanced models of NDM are required for such areas and look forward

to developing future research questions.

Conclusive remarks

Our thanks go to all the contributors and to the referees (of both the selected and unselected manuscripts) for their critical, timely and high constructive reviews. For the scholars whose work did not make the special section, we hope that you will be encouraged to continue to refine your NDM studies. Particular thanks go to Hannah Wakely at Wiley who kept the editorial team on track and to the friendly and sceptical behavioural decision research scholars who continue to question our presentation of argument, methods and results. By acknowledging their concerns, we hope that we provide an alternative approach which will also capture their curiosity and interpretations of cognitive decision making processes.

We hope that you too reader, find the work presented here theoretically informed, methodologically challenging, creatively executed and a pragmatic and highly relevant field for occupational and organizational psychology to continue to explore.

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Table 1

Range of Context, Theoretical considerations, Methods & Analysis covered in the special section

Domains of Expertise	Theoretical Considerations	Methods/ Analysis
Healthcare, USA	Situation awareness	After-actions reviews
Offshore maritime, Norway	Macro-cognition	Cognitive task analysis
Air Force Pararescue, USA	Expertise	Simulation exercises
Fire, UK	Sensemaking	Depth interviewing
Ambulance, UK	Insight	Argumentation analysis
Police, USA, UK	Decision Interia	Functional analysis
Military, USA	RPD	Induction
Elite Sports, France	Time	Observation
Labour relations, Malaysia	Argumentation	Ethnography