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# On the Importance of Mental Time Frames: A Case for the Need of Empirical Methods to Investigate Adaptive Expertise

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It has been suggested by Holyoak (1991) that research on expertise can be divided into three generations. The first two focused on expertise as heuristic search and expertise as refined routines. The third generation acknowledges the adaptive character of expertise, which is the topic discussed here. We take as the starting point the operational definition of adaptive expertise, and the three key elements of adaptive performance for individuals and teams recently suggested by Hutton et al. (2017). This definition captures the essence of this skill; we however suggest that the key definition needs further elaboration. We reason that understanding and achievement are perhaps best understood in terms of action-recognition cycles. In addition, empirical examples from five different domains are used to show how time pressure affects self-monitoring and regulates experts' cognitive strategies. We propose that mental time frames explain how, and how well, domain experts in naturalistic decision situations manage different kinds of time pressure. In our field research, utilising the collegial verbalisation (CV) method, we have found evidence for use of mental time frames in experts' decision making processes. We suggest that CV, along with the use of conspective protocols, is both a robust method and an innovative approach for collecting data in naturalistic decision making research. This method can help identify individual differences which are an important source in understanding adaptive expertise.

***General Audience Summary***

In this paper we discuss the concept of adaptive expertise. In addition to a previous definition and set of principles, we propose a similar way to understand the concept, but we emphasise the iterative nature of understanding and goal achievement in naturalistic decision situations. With empirical examples from five different application domains, we show how time pressure affects self-monitoring and regulates skilled experts' dynamic behaviours. We propose mental time frames as explanations of how, and how well, the domain experts manage different kinds of time pressure. It is necessary to find methods for empirical investigations of adaptive expertise, and we therefore suggest a new and innovative method for collecting data in this area of research. Individual differences are important sources in the efforts to better understand the nature of adaptive expertise.

*Keywords:* Decision making, Adaptive expertise, Knowledge elicitation, Verbalisation, Cognitive strategies

Research on expertise has often had a focus on how individuals refine routine behaviour through hours of deliberate practice (e.g., Ericsson, Krampe, & Tesch-Römer, 1993). Hatano and Inagaki (1984), however, made a distinction between routine and adaptive expertise, pointing to the need to acknowledge how experts of many domains have to adapt to the changes of their environment and often apply novel solutions to accommodate dynamic problems. Holyoak (1991) echoed this concern and

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recognised three paradigms within the expertise research community. He suggested that Newell and Simon's ideas of general problem solving and heuristic search constituted the first generation of ideas of expertise. This was later replaced with the notion that expertise was strongly related to domain-specific knowledge developed through practice. The idea of adaptive expertise is an important realisation that has its place within naturalistic decision making (NDM). Within this community, it has long been recognised that experts tend to make recognition-primed decisions (Klein, Calderwood, & Clinton-Cirocco, 2010), and furthermore, that the situations facing these experts are dynamic and these individuals thus have to be flexible to environmental changes. Thus, defining and working more on adaptive expertise is a natural next step within NDM in that we need to incorporate cognitive reflection and analysis in conjunction with intuition to nuance expertise in natural environments, thereby highlighting how experts are complementing pattern matching with analytical thinking. We therefore suggest that this topic should be further investigated and offer, through the present paper, a method called collegial verbalisation (CV) which we have developed over the years that amply captures characteristics of adaptive expertise which can otherwise elude an observer.

Hutton et al. (2017, p. 83) proposed, as a result of a literature review, the following operational definition of adaptive expertise: "Timely changes in understanding, plans, goals, methods in response to either an altered situation or updated assessment about the ability to meet new demands, that permit successful effort to achieve intent." Further, Hutton et al. (2017) clarified that their definition encompassed three key elements of adaptive performance for individuals and teams: (a) understanding of a situation, (b) actions required to achieve intent, and (c) self-awareness to balance the situational and task demands with the ability of the individual (and the resources at his or her disposal) to achieve the intent.

This definition captures the essence of adaptive expertise; we suggest however that the key elements presented need further elaboration. In this paper, we take as the starting point this operational definition, proposing both a clarification and an extension of the key elements of adaptive expertise, highlighting the importance of one particularly crucial aspect, namely that of *mental time frames*. Time pressure is of course one aspect that implicitly affects naturalistic decision making situations that an adaptive expert must handle, but more specifically, we argue that professionals possessing adaptive expertise take time frames explicitly into consideration.

Based on empirical examples from our research on dynamic decision making (Brehmer, 1992), we first argue that it is necessary to extend the key elements of adaptive expertise to include time pressure as a factor that shapes the cognitive strategies associated with adaptive expertise. Second, field studies of professionals show how individual differences as well as time pressure modulate cognitive strategies, and as such, they both help qualify and critically analyse the proposed key elements of adaptive expertise. Finally, we argue for the need of methods to investigate adaptive expertise empirically and propose the use of collegial verbalisation (CV). We believe that the CV method and the use of conspective protocols (Jansson & Axelsson, 2017; Jansson, Erlandsson, & Axelsson, 2015) are an appropriate approach for conducting investigations on adaptive expertise.

## Extended Elements of Adaptive Expertise

With the definition of Hutton et al. (2017) in mind, we first of all would like to emphasise that we share the idea of connecting understanding with achievement in a definition of adaptive expertise. All too long have these two subjects been kept apart in studies on human judgment and decision making. These two parts shape each other; model building and goal achievement cannot be separated if we wish to understand human behaviour in applied and complex decision situations. Jansson (1999, pp. 26–29) describes in detail the very complex relation between understanding and achievement, the effect it has on performance, and how this can be investigated with the help of the micro-worlds (i.e., computer-simulated dynamic decision tasks; Brehmer & Dörner, 1993). In order to develop the skills necessary for controlling the decision task, the participants must not only develop a sufficiently good model, they must also operationalise the general goals so that they are precise enough to be implemented in the simulation, and they have to carry out these separate cognitive tasks in parallel in order to perform well. Jansson (1994, 1995b) showed that it was only those participants who adapted their cognitive strategies to the degree that they developed a sufficiently good understanding of the decision task who were able to execute timely decisions in response to the altered situations. Jansson (1995a) interpreted the adaptive strategies of the successful participants as heuristic competence, and he also showed the effect of teaching such strategies by instructions, meaning that those participants who heeded the instructions performed well. In the context of the current paper, we believe the results by Jansson were experimental demonstrations of how adaptive expertise can manifest itself on the behavioural level, and in particular, the importance of realising the interconnectedness of understanding and achievement.

Second, we also agree that self-awareness is an important subject, but we would like to single out one particular part of self-awareness most crucial to adaptive expertise, namely self-monitoring. This is a more operational and therefore more useful self-awareness aspect of adaptive expertise.

Third, in addition to the three key elements of Hutton et al. (2017), we would like to emphasise a fourth element: the impact of time. As can be realised from the suggested operational definition by Hutton et al. (2017), timely changes as responses to altered situations and updated assessments are indications of a very important characteristic of decision making behaviours in volatile and uncertain situations, which is that such behaviours are *dynamic*. And dynamic decision making behaviours are best understood in terms of cognitive strategies for dealing with altered situations and updated assessments (Brehmer, 1990).

Hutton et al. (2017) argue that recent literature on adaptive expertise has largely focused on identifying individual-difference characteristics of expertise, and that there has been less emphasis on adaptation based on the decision makers conceptual understanding and the cognitive mechanisms

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