WHAT MATTERS IF NOTHING REALLY MATTERS? WORKPLACE LEARNING UNDER CONDITIONS OF HETEROGENEITY AND UNCERTAINTY IN A DEPARTMENT OF ANAESTHESIOLOGY

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Abstract

The paper focuses on the interrelation of heterogeneous and uncertain working conditions on the one hand and knowledge and learning processes on the other. The construction of consistent knowledge is difficult - and sometimes even regarded as dangerous - in organizational contexts likely to produce unexpected events. We reflect upon what and how people learn in such work environments by proposing the social psychological concept of metaknowledge as a complement to Weick and Sutcliffe's notion of 'mindfulness'. As illustration of our arguments, we present first results of a research project focusing on the introductory period of nurse anaesthetists.

Keywords: workplace learning, uncertainty, metaknowledge, situated learning.

What matters if nothing really matters? Workplace learning under conditions of heterogeneity and uncertainty in a department of anaesthesiology

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Suggested track: G Organizational learning

1 Introduction

"What is really stressful and confusing is that you cannot rely on what you have learnt the day before because potentially it will not be valid any more on the next day." (novice nurse anaesthetist in his first month at work)

"I do not teach routines. They can be very dangerous in medical treatment." (experienced nurse anaesthetist)

Usually we regard the content of knowledge as propositions about things in the world (facts, procedures, laws of nature, etc.), whereby these propositions are characterized by a certain degree of stability, continuity and order (see e.g. Brüggen, 1974). This characteristic of knowledge allows for the construction of stable predictions and expectations which is a precondition for what Giddens (1984) describes as ontological security. Such a kind of perceived stability enables agents to plan and take action based on this knowledge. We 'know' that the sun will rise the following morning, because we perceived it behaving this way every day, and based on this assumption we plan our activities for the next day. This applies

also to the realization and reproduction of any kind of practices in organizations. Knowledgeable agents (Cohen, 1989) need to perceive the underlying stable pattern of a practice in order to act according to this pattern (Becker & Brauner, 2003).

In this respect it doesn't matter if there really *exists* an inner order and stability of the things per se, as put forward by proponents of realist epistemology. It is just necessary for us to 'see' any continuity in order to be able to (re)act. Human beings – not only scientists - are real experts in 'order-construction' (Eibl-Eibesfeldt, 1997; Glasersfeld, 1997). They construct for example objects, individual habits, characteristics of a certain group of people, typical work processes and organizational routines. The more stable the environment is perceived by an individual, the easier it will be to build expectations and vice versa knowledge, and thus learn about these stabilities (Piaget, 1970). Even though we are excellent in constructing reality as an ordered (e.g. in the sense of cause-effect relationships) and stable one, we sometimes fail to do so. We are surprised by unexpected events or even perceive them as chaotic which is mostly accompanied by an unsettling feeling of uncertainty.

Weick and Sutcliffe (2001) have recently pointed out that some organizations, termed 'high reliability organizations', are characterized by a very high probability of providing unexpected events to their members. Such organizations need to detect abnormal events in time in order to function reliably. That means that people should feel alarmed even by minor irregularities because of their possibly dramatic impacts. Weick and Sutcliffe describe relevant behaviour under such circumstances, but they do not address issues of knowledge in terms of specific kinds of knowledge necessary to cope with unexpected situations or in terms of knowledge acquisition and learning processes. Presumably, organizational complexity and uncertainty present a challenge for learning processes due to lack of perceived order and continuity. Confronted with complex systems including e.g. changing processes, routines, norms and colleagues, people may find it difficult to build stable expectations. On the other hand, learning could be stimulated as the consciousness of lack of knowledge is raised.

Literature on knowledge management rarely deals with issues regarding uncertainty of knowledge or knowledge creation and learning in uncertain and complex social and organizational contexts. In organization and management research, complexity and learning have mostly been associated with each other only insofar as it has been stressed that organizations have to become 'learning organizations' in order to adapt to dynamic, fast changing environments and increased competition (see e.g. Dodgson, 1993; Senge, 1990).

In this paper we will explore which kind of knowledge is relevant in, and possibly fostered by, work settings characterized by high levels of uncertainty and heterogeneity. Furthermore, we will touch on the subject of knowledge acquisition and learning processes under such working conditions.

In the first part of the paper, we will argue that a social psychological perspective on workplace knowledge and learning, namely the concept of meta-knowledge (Brauner, 2002), serves as an insightful complement to Weick and Sutcliffe's (2001) notion of 'mindful management'. In the second part of the paper, we will turn to an empirical research project currently conducted at the Department of Anaesthesiology at the university hospital of Innsbruck. The study focuses on the introductory period of novice nurse anaesthetists who are confronted with high levels of heterogeneity and uncertainty at work. We will present and discuss tentative results of this study which is still in progress. These shall serve as illustrative examples of the theoretical perspective developed in the first part of the paper.

2 Social psychology on mindfulness

In this section we will develop a social psychological perspective on knowledge and learning processes in heterogeneous and uncertain social and organizational contexts likely to produce unexpected events. We will argue that the concept of metaknowledge may serve as complement to more managerial and 'organizational' views, notably Weick and Sutcliffe's (2001) mindful management. First, we criticize the imprecise use of notions as 'organizational knowledge' and 'organizational learning' in knowledge management and organizational learning literature. We will then take a look at theoretical approaches in organization research dealing with complexity and uncertainty and discuss them in terms of knowledge and learning. In the last part of this section we will introduce the concept of metaknowledge and show its usefulness as a complement to the aforementioned approaches.

2.1 Knowledge and learning in organizations

Theories explaining how knowledge can be coordinated and distributed within an organization are in good currency in organization research these days. It is remarkable in this context that, as Brauner (2002, p.151) puts it, "most of these theories conceive organizational knowledge as shared knowledge", emphasizing the necessity of sharing knowledge among organizational members and proposing ways of how this can best be achieved. Writing in the tradition of Nonaka and Takeuchi (1995), many authors focus on how knowledge can be made explicit and thus accessible for distribution within the organization (for a review see Kakabadse & Kouzmin, 2003). This approach is accompanied by a terminology conveying a rather imprecise image of the processes surrounding knowledge and learning in organizations. The use of concepts such as 'organizational knowledge' and 'organizational learning' often covers the fact that knowledge has to be acquired by individuals through multiple, often interactive, processes and exposed to diverse social and organizational contexts. Moreover, the concern with rendering knowledge explicit correlates with the idea that knowledge is something 'objective', relatively independent of

actual situational and personal circumstances. Otherwise, it would not make sense to pay that much attention to how existing knowledge can best be stored e.g. in databases in order to distribute it. This dominant perspective on knowledge and learning taken in the literature is thus based on assumptions concerning the content of knowledge and concerning knowledge relevant processes (as processes of knowledge creation, learning and communication processes), whereby the latter is related to the location of knowledge.

Objective nature of knowledge. As indicated above, we suggest questioning the objective nature of knowledge explicitly or implicitly assumed in the literature. Alvesson and Kärreman (2001, p.999) state that: "From a knowledge management point of view, knowledge is thus objective (justified true belief) and thing-like." In a similar vein, Styhre (2003, p.33) argues that: "[…] knowledge management theory often conceptualizes the notion of knowledge on the basis of a realist epistemology postulating that knowledge is an entity per se that can be treated like some tangible resource […]. Conceiving of knowledge as being a stable and somewhat fixed entity is based on a number of epistemological assumptions that are rarely explicitly addressed in the knowledge management literature." Only if knowledge is assumed to be an objectively existing resource (and thus also featured by some sort of continuity), one may in fact talk of 'management of knowledge'. The assumption of continuity and objectivity of knowledge content is arguable and problematic especially with regard to workplace knowledge. What relevant knowledge is does depend on the specific circumstances of the work conditions in place. As has been stressed by theorists on situated learning (Lave & Wenger, 1991; Tyre & Hippel, 1997), processes, routines and norms can differ substantially even within an organization. This applies in particular to work settings characterized by high levels of heterogeneity and uncertainty. Respectively, dynamics of this kind are themselves one important feature of such organizations, as we will discuss in the second part of this paper. Therefore, we argue that knowledge cannot be understood as abstracted from concrete situational contexts. Rather, generalized forms of knowledge often do not matter that much for coping with concrete situations. To obtain an understanding of how people cope with concrete situations at work, it thus makes sense to study such processes *in situ*, and to look at what kind of knowledge people need to manage various situations and how this knowledge is transferred and acquired. Furthermore, the study of organizations which are characterized by a very high probability to provide unexpected events may serve as a case in point and may therefore be suitable to explore such questions.

Knowledge acquisition and location of knowledge. Knowledge is often regarded to be located in the organization as such, in its routines, norms, standard operating procedures, organizational myths and the like (see e.g. Dodgson, 1993; Huber, 1991; Hedberg, 1981), in organizational mental maps (e.g. Kim, 1993), in practices (Styhre, 2003) or in communities of practice (Brown & Duguid, 1991; Wenger, 1998). Scholars of the communities of practice approach, notably Lave and Wenger (1991), stress the situated nature and interactive character of learning processes. In contrast to many authors writing from a more technical perspective, they thus avoid trivializing the processes of knowledge acquisition and learning. In arguing that knowledge acquisition processes are strongly practice-based, they claim that learning cannot be accomplished by simply storing and distributing information via electronic databases. However, they correspondingly suggest that knowledge is located in these very practices rather than in individual minds (e.g. Gherardi, 2000; 1999). Thus, knowledge is not clearly differentiated from the learning processes leading to knowledge formation. We suggest that conceiving of knowledge as bound to the individual does not contradict with the interactive view of learning. Rather, a social psychological view of knowledge, regarding data or information as knowledge only when they are interpreted in a wider context by an individual (Brauner, 2002; Henschel, 2001), may serve as insightful complement to the aforementioned concepts, whereby each concept may help to see different things or things differently, respectively. According to the social psychological concept, knowledge – as information which is contextualized in a cognitive system - is regarded as bound to the individual. This means that an understanding of knowledge creation requires that the latter is ultimately linked to learning processes. These learning processes are individual insofar as individuals have to acquire knowledge. As individuals, they are engaged in learning processes, with their perception, action and cognition. On the other hand, learning processes in organizations are also social and organizational in that they take place in a social and organizational context. Learning, especially workplace learning, takes place in the interaction between people (see Lave & Wegner, 1991) and is influenced by organizational factors, as e.g. hierarchical structures. Therefore, we argue that a more thorough understanding of such learning processes with regard to both aspects mentioned above, the individual *and* the social-organizational, will contribute to any attempts at the management of knowledge. Empirical research concerning these issues is lacking both in the knowledge management literature and in the field of organizational learning, as Easterby-Smith and Araujo (1999, p.11) put it: “It seems to us that the most common forms of empirical research […] privilege outcomes as indicators of learning processes over the processes themselves. In our view there is a particular shortage of studies that attempt to induce theory from existing practice, use a small sample of in-depth cases, focus on micro-practices within organizational or trans-organizational settings and study processes leading to learning outcomes.”

It is the aim of our empirical study in the department of anaesthesiology to account for both theoretical shortcomings discussed in this section, notably the abstraction from the individual (implying the neglect of learning processes) and the abstraction from the specific context in which knowledge has to be applied and in which learning takes place (implying objectivity of knowledge content and neglecting the situated nature of knowledge and learning). As pointed out before, we will concentrate on the interaction of heterogeneous and uncertain working conditions on the one hand and knowledge and learning processes on the other.

2.2 Perspectives on heterogeneity and uncertainty

In organization research phenomena of heterogeneity and uncertainty are mostly addressed with reference to the notion of complexity. Systems, like organizations as social systems, exhibit complex behaviour insofar as the interaction of their elements produces surprising, emergent behaviour, also referred to as non-linear, chaotic, dynamic or random (Anderson et al., 1999). This means that cause-effect relationships are not easily comprehensible either for agents within or outside such systems. This makes it hard to predict what will happen next and, as a consequence, to plan ahead. Hence, uncertainty is likely to emerge. Whereas uncertainty is viewed as an effect of the dynamics encompassing complexity, heterogeneity of agents, tasks and other independent variables is conceived as a feature or cause of complexity (e.g. Mc.Kelvey, 1999).

This interrelation of heterogeneity, complexity and uncertainty in mind, we will in this section briefly present some approaches to organizational complexity, focusing on Weick and Sutcliffe's (2001) notion of 'mindful management'.

Organizational variation in complexity and uncertainty. In his analysis on high-risk technological systems, Perrow (1984) most prominently links uncertainty to complexity in that he connects the probability of systemic accidents which are characterized by unpredictable interactions between different errors/failures to system characteristics of complex interaction and tight coupling (as opposed to linear interaction and loose coupling). As complex and tightly coupled systems he categorizes e.g. nuclear power stations, planes, nuclear weapons and astronautics. Complex interactions are interactions between components and events which were originally not 'designed' to interact. (Applied to systems in general we would reword this, stating that an interaction is perceived as complex if we can't interpret how and why this interaction takes place; or as cognitive psychologists would put it, if we do not have at our disposal mental maps, schemata or scripts to interpret what happens.) Furthermore, these interactions exhibit multivariate non-linear cause-effect relationships and feedback loops. Therefore, it is hard to make sense of them and to manage them appropriately. Tight coupling, on the other hand, stands for direct, imminent interactions between different incidents. In tightly coupled systems the production processes neither allow for

disruptions/time-outs nor for flexible adaptations as they are bound to determined procedures. There is no or little scope of action, which makes such systems especially vulnerable in case of failures.

Knowledge is addressed here only insofar as skill and knowledge of people working in complex systems is characterized as specialized rather than generalized and thus individuals are not easily substituted. Complex interactions are difficult to predict, because the individuals involved cannot possibly possess *knowledge* of all potential kinds of interaction (for the boundedness of human cognition faced with complex problems from a psychological point of view see also Dörner, 1983 and Simon, 1990). The specialization of individuals' knowledge in such systems then makes it even more difficult for them to gain an understanding of the interactions in place.

The idea that organizations differ (more or less systematically) in their levels of complexity and uncertainty is also prevalent in Weick and Sutcliffe's (2001) work on managing the unexpected. They label organizations in which their members are rather 'routinely' exposed to unexpected events 'high reliability organizations'. Organizations like nuclear aircraft carriers, nuclear power generation, emergency medical treatment and firefighting crews have no choice but to function reliably, because otherwise, severe harm results. The reason for the high frequency of unexpected events in these systems is presented as follows: "They face an excess of unexpected events because their technologies are complex and their constituencies are varied in their demands – and because the people who run these systems, like all of us, have an incomplete understanding of their own systems and what they face." (ibid., p.3). The authors argue that such organizations rarely fail even though they encounter numerous unexpected events. They had become experts in dealing with the unexpected by necessity. Hence, there is much to learn from them in terms of managing the unexpected. In their analysis Weick and Sutcliffe adopt a managerial perspective, as they point out management techniques, subsumed under the concept of 'mindful management', and correspondent structural properties that enable organizations to cope better with unexpected events, namely: preoccupation with failures, reluctance to simplify, sensitivity to operations, commitment to resilience and deference against expertise. These aim at either averting the unexpected by detecting it as early as possible or dealing with the unexpected once it has occurred.

Note that it is assumed in this approach that it is impossible to completely avoid unexpected events or respectively to gain full knowledge of interactions in the system. Mindful management then alludes to raising 'organizational' awareness of the fact that every situation might be slightly different, that even small deviations might have unforeseeable fatal effects and awareness of the own ignorance and imperfect knowledge: "By mindfulness we mean the combination of ongoing scrutiny of existing expectations, continuous refinement

and differentiation of expectations based on newer experiences, willingness and capability to invent new expectations that make sense of unprecedented events, a more nuanced appreciation of context and ways to deal with it, and identification of new dimensions of context that improve foresight and current functioning." (ibid. p.42). In a similar vein, the relevance of organizational unlearning in order to make way for new responses and mental maps has been stressed by Hedberg (1981).

Uncertainty and knowledge. The importance of "experiencing sensitively more aspects of experience" when faced with infrequent critical events has also been emphasized by March, Sproull and Tamuz (1991) in their essay on learning from samples of one or fewer. According to their argumentation, single events have to be experienced more richly in order to learn, taking into account processes leading to an event (focusing not exclusively on the outcome) and different perspectives on and interpretations of an event. Thus, the relevant knowledge necessary to "experience events more richly", to unlearn or to behave mindfully, must be somewhat different from our usual conception of knowledge as knowing what and knowing how, enabling us to build stable expectations, which in social psychology is referred to as 'object-level knowledge' (see e.g. Brauner, 2002). Such 'illusion' of stability, according to Weick and Sutcliffe is even regarded as dysfunctional and dangerous in high reliability organizations: "People in HROs try to weaken the grip of this invisible hand of expectations so they can see more, make better sense of what they see, and remain more attuned to their current situation." (Weick & Sutcliffe, 2001, pp. 41-42). But there is at least one stable expectation they have to build in order to be 'mindful' and raise situated awareness: the expectation that something unexpected might happen all the time, that means the expectation that something might happen that they can't anticipate and the development of which they do not fully understand. This kind of knowledge can be regarded as one sub-category of meta-level knowledge, which is in this case the knowledge about one self's ignorance. This type of meta-knowledge can be of exceptional importance, e.g. to raise one's awareness of need for help in a critical situation (Brauner, 2002).

Weick and Sutcliffe (2001; 2003) draw a rather detailed picture of how people need to behave in high reliability organizations and point out some managerial activities to foster this kind of behaviour, without discussing further issues of knowledge and learning. Sensitivity to the situation at hand and willingness to scrutinize and overthrow old expectations in favour of new experiences in new situations are major features of mindfulness (see also McKenna, 1999). Ortmann (2003) states that this disposition to heed - to be able to make exceptions to rules as e.g. standard procedures according to the situational needs - is necessary in every rule-dominated social and organizational context. It is this heedful rule breaking, the exception which proves the rule, which keeps going and fosters organizational life (including its rules), as opposed to work-to-rule. Faced with this 'need to heed' on the one hand and the

human propensity to build expectations and to rely on them on the other, it is worth questioning what kind of knowledge fosters heedfulness/situational awareness and how people learn to overthrow expectations in order to be more sensitive to situational factors. According to Ortmann (ibid.), this kind of knowledge must be something comparable to Aristotle's (1998) *phrónesis*, Kant's (1963) *power of judgment* and Gadamer's (1990) *sensus communis*. We will try to elaborate more on this kind of knowledge by proposing the social psychological concept of metaknowledge (Wegner, 1987; Brauner, 2002) as at least one kind of knowledge essential to heedfulness. In the next section we will first present this concept and then associate it with uncertainty and learning under conditions of uncertainty.

2.3 Metaknowledge and uncertainty

The concept of metaknowledge. In social psychology metaknowledge is conceived of as knowledge stored in an individual's memory about own or other people's object-level knowledge. Metaknowledge can be differentiated first, regarding the location (own or other people's), quality and trustworthiness of the respective object-level knowledge, and second, regarding the mode/sort of relationship between metaknowledge and object-level knowledge (monitoring the knowledge content or controlling processes of acquisition and retrieval of contents). Brauner (2002, p.38) develops this latter differentiation by relating metaknowledge to the common typology of declarative-procedural and implicit-explicit knowledge (see Table 1 below).

This classification shows first, that metaknowledge is by definition explicit knowledge, that is to say conscious and verbalizable knowledge. Second, declarative metaknowledge is distinguished from procedural metaknowledge. Declarative metaknowledge concerns the monitoring of cognitive contents or metacognitive knowing about a product that is (or is not) available in memory, as e.g. knowing if I possess enough knowledge to be able to handle a machine on my own or the judgment whether something has been learned or how easy it will be to learn something, whereas procedural metaknowledge comprises controlling cognitive processes or metastrategic knowing about processes, as e.g. rehearsal strategies or mnemonic devices. A functional definition of metaknowledge is presented by Brauner (ibid, p.40) as follows: "[…] metaknowledge has the function to monitor and control the object-level database. For metaknowledge about own knowledge this means that an individual (meta-) cognitive process takes place that monitors and controls individual cognition. For metaknowledge about other people's knowledge this means that a social process of monitoring and control takes place that directs the use and retrieval of object-level knowledge in the transactive knowledge system."

Table 1. Interrelations between different kinds of knowledge
(adapted from Brauner, 2002, p.38, extended by examples from our research project)

	Explicit Knowledge		**Implicit Knowledge**
	Object-Level Knowledge	**Meta-Level Knowledge**	**Object-Knowledge**
Declarative Knowledge	• Knowledge about the world • Knowledge about facts • Knowledge about the self *e.g.: knowledge that isoflurane is an inhalation anaesthetic*	• Feeling of (not) knowing • Judgment of learning • Ease-of-learning judgment • Confidence in correct retrieval *e.g.: knowledge that I do not possess enough knowledge to handle a specific technical device (e.g. how to refill the inhalation machine); knowledge that my colleague in the next operating room is an expert in this field*	• Unconscious knowledge about facts • Cultural common ground • Stereotypes, attitudes, schemas *e.g.: stereotype that my female colleagues are not skilled in handling technical devices*
Procedural Knowledge	• Knowledge about how to do things • Skills in early stage of acquisition • Mathematical problem solving • Second Language generation in early stages of acquisition *e.g.: verbalizable knowledge about how to refill the inhalation machine: first, you have to …, then …, finally … (similar to an instruction manual)*	• Selection of kind of processing • Allocation of study time • Termination of study • Selection of search strategy • Termination of search *e.g.: knowledge that I will not be able to learn to handle the technical device by watching my colleague, but that I need to try it myself several times*	• Unconscious knowledge about actions • Scripts for acting • Greeting behaviours • Conversational rules • Automated skills *e.g.: automated refilling skills (I cannot explain how to handle the inhalation machine, but faced with it, I can do it)*

As discussed above, one major aspect of managing uncertainty is heedful scrutinizing of old expectations and knowledge in a specific work situation. In this respect, metaknowledge holding the function of monitoring and controlling object-level knowledge might play an important role. In the following section, we will therefore link the two concepts of metaknowledge and mindful management in order to outline the relevance of metaknowledge in coping with uncertainty.

Metaknowledge as social psychological complement to 'mindful management'. If an actor knows that her (object-level) knowledge will possibly not be applicable any more the next day, she will most probably raise her propensity to monitor her current knowledge in terms of accurateness, and she will try to develop strategies to adjust her knowledge rather quickly, e.g. by applying search strategies for reliable knowledge sources. The interplay and overlap of mindfulness and metaknowledge becomes rather transparent with this example.

The described consequent behaviour (select and apply knowledge updating strategies) is what Weick and Sutcliffe (2001) presented as scrutiny of existing expectations or more generally 'mindfulness'. In 'knowledge terms' this is based on procedural metaknowledge, whereas the preceding, conditional state (awareness of one's imperfect knowledge) is characterized by declarative metaknowledge. To elaborate more thoroughly on this interrelation of the two concepts we will now discuss in more detail Weick and Sutcliffe's (ibid.) 'five hallmarks' of mindfulness: preoccupation with failure, reluctance to simplify interpretations, sensitivity to operations, commitment to resilience and deference to expertise.

We will first quote characteristics of mindful behaviour as described by Weick and Sutcliffe (ibid.), and subsequently propose types of knowledge on which such kind of behaviour is based.

Preoccupation with failure. "They [high reliability organizations] treat any lapse as a symptom that something is wrong with the system […] HROs encourage reporting of errors, they elaborate experiences of a near miss for what can be learned, and they are wary of the potential liabilities of success […]" (ibid., pp. 10-11).

In order to look for errors and report them, actors need several kinds of knowledge: First, they need knowledge about the necessity to detect and report failures and near misses. That means that they need to know that thereby they or others can learn something, which in turn means that they need to know that their own or other people's knowledge is not perfect. This type of knowledge is declarative metaknowledge about one's own and other people's knowledge. Second, to notice errors, actors need knowledge about normal processes and routines in order to detect deviations from these processes, that is object-level knowledge. Finally, the detected errors have to be reported. To do so, actors have to know that the reporting of errors is a means for updating imperfect knowledge and furthermore, they have to know that this reporting is appreciated (especially in case of self-induced mistakes). The knowledge about updating processes is procedural metaknowledge, whereas the knowledge about others' (notably of those performing managerial tasks) appreciation of error reports implies the knowledge about other people's knowledge concerning the necessity of error reporting. This is shared metaknowledge, since several people in the organization mutually need to possess this knowledge about the others' knowledge.

Reluctance to simplify. "HROs take deliberate steps to create more complete and nuanced pictures. They simplify less and see more. Knowing that the world they face is complex, unstable, unknowable, and unpredictable, they position themselves to see as much as possible. They encourage boundary spanners who have diverse experience, scepticism

toward received wisdom, and negotiating tactics that reconcile differences of opinion without destroying the nuances that diverse people detect." (ibid. pp. 11-12).

Again, actors need to be conscious of the insufficiency of their own and other people's knowledge (declarative metaknowledge) in order to open their senses and to accept different opinions. There is also procedural metaknowledge involved in so far as looking for different opinions is regarded as a method to learn. Moreover, knowledge about boundary spanners' expertise (declarative metaknowledge) is required in order to position them effectively.

Sensitivity to Operations. "They [HROs] are attentive to the front line, where the real work gets done. The 'big picture' is less strategic and more situational than is true of most other organizations. When people have well-developed situational awareness, they can make the continuous adjustments that prevent errors from accumulating and enlarging." (ibid. p.13). Everybody from top to bottom understands the language of operations. People are not scared to speak up concerning symptoms of the system and they know that they need to speak up.

This hallmark overlaps to a certain extent with the first one (preoccupation with failures). Thus, what is stated above, applies here as well. Additionally, it is stressed that everybody has to be acquainted with the language of operations (shared object-level knowledge). Using this language (e.g. for error reporting), actors expect that these reports are understood, which requires shared metaknowledge about others' familiarity with the language.

Commitment to resilience. "HROs develop capabilities to detect, contain, and bounce back from those inevitable errors that are part of an indeterminate world. […] Resilience is a combination of keeping errors small and of improvising workarounds that keep the system functioning. Both these avenues of resilience demand deep knowledge of the technology, the system, one's coworkers, one's self, and the raw materials. HROs put a premium to experts." (ibid. pp. 14-15).

Knowledge is addressed here explicitly as both object-level (about technology, raw materials, worst case conditions, etc.) and meta-level knowledge about own and other people's knowledge. To put a premium to experts entails that shared object-level knowledge is very hard to obtain. Individuals cannot possibly absorb all the requisite knowledge domains for their team's performance (e.g. Sapsed et al., 2002). The development of shared metaknowledge about each other's expertise, then, is a prerequisite for effective planning, coordination and problem solving (Moreland, 1999; Brauner, 2002).

Deference to expertise. "HROs cultivate diversity, not just because it helps them notice more in complex environments, but also because it helps them do more with the complexities they spot. Rigid hierarchies have their own special vulnerability to error. […] HROs push decision making down – and around. Decisions are made on the front line, and authority migrates to

the people with the most expertise, regardless of their rank. […] The decisions migrate around these organizations in search of a person who has specific knowledge of the event. […] HROs differentiate between normal times, high-tempo times, and emergencies and clearly signal which mode they are operating in. Decisions come from the top when it is normal, they migrate during high-tempo operations, and a predefined emergency structure kicks in when there is danger the ship could be lost. These clear signals tell everyone when migration is crucial and when it is not." (ibid., pp. 16-17)

Actors can't rely on stable organizational routines of decision-making. Depending on the situation decision-making patterns change. Individuals acting according to these patterns not only need knowledge about these patterns, but also knowledge about the signals that indicate the need to replace one pattern by another (e.g. in order to decode signals indicating that a situation requires decision-migrating rather than hierarchical decision-making). Again, scepticism towards own and other people's knowledge is required (declarative metaknowledge) to obtain situational awareness and sensitivity to the aforementioned signals. Ideally, knowledge about the signals and the adequate decision-making practices is shared, otherwise conflicts could emerge easily. In the decision-migrating mode metaknowledge plays a major role, since the search for the most competent person becomes more efficient if knowledge concerning others' expertise is available.

This elaboration on characteristics of mindfulness shows a strong connection between the concepts of mindfulness and metaknowledge. Consequently, insights about acquisition and development of metaknowledge might broaden our understanding of how mindful behaviour emerges.

In this section we stressed the necessity to examine knowledge and learning processes in organizations as related to the specific circumstances of the work conditions in place. As a case in point we elaborated on the interrelation of heterogeneity and uncertainty and knowledge in high reliability organizations. Here, we proposed to enrich Weick and Sutcliffe's (2001) notion of mindfulness by the social psychological concept of metaknowledge (Brauner, 2002). In the next section, we will draw on empirical data stemming from a research project conducted at a department of anaesthesiology to illustrate our argument and give concrete examples of the enactment as well as the development of metaknowledge.

3 Workplace learning in a department of anaesthesiology

In medical treatment different kinds of anaesthesia are required on a wide range of different occasions. Experts in anaesthesia, medical doctors as well as nurses, mainly working at hospitals, mostly migrate around several workplaces, faced with diverse fields of application, different colleagues, surroundings and routines. The research project which will be presented and discussed in this section is currently conducted at the department of anaesthesiology at

the university hospital of Innsbruck, situated in the Western part of Austria. With over 75 nurse anaesthetists, 130 anaesthetists and 85 workplaces the department counts among the biggest departments of anaesthesiology in Europe. The study focuses on the introductory period of novice nurse anaesthetists. In the hospital studied, these nurses have to go through a one year's period of job rotation across the main existing departments. After this period of organized change they are expected to continue to rotate according to the needs of the departments. This means that they need to stay very flexible. For example, during nights and weekends, nurses have to cover several departments (situated at different locations) at the same time, given that staff resources are low at these special times. These heterogeneous work conditions constitute the first main source of uncertainty at this department. The second one lies in the nature of the work itself. Nurse anaesthetists mainly assist the anaesthetist before, during and after any narcoses. In hospitals, this means that they mainly have to work in diverse operating and emergency rooms. Medical treatment in general is characterized by uncertainty in so far as the patient as co-producer, being a complex system, is not easily comprehensible and predictable in his/her behaviour and reactions. Furthermore, medical treatment has to 'function' reliably, notably during the high-risk conditions of surgeries. According to the research question alluded to in the beginning of the paper, we focus on the interrelation of heterogeneous and uncertain work conditions on the one hand and knowledge acquisition and learning on the other.

3.1 Methodological issues: how to grasp 'knowledge' and 'learning'

"Learning is a notoriously difficult process to investigate empirically […]" (Easterby-Smith & Araujo, 1999, p. 12).

Data about learning experiences of the nurses are collected throughout seven months, whereby the research process is strongly based on ethnographic methodology (e.g. Geertz, 1973). Six novice nurses are accompanied during their first months of work. This means that one researcher spends several full working days per month with each newcomer, observing how the nurse copes with the new working environment. Field notes are taken on an observation protocol, focusing on interactions (notably knowledge relevant processes) in which newcomers are involved. In addition, narrative interviews with both novice and experienced nurses based on the critical incidents technique (Flanagan, 1954) are conducted at the end of each month. Moreover, the researchers analyze relevant documents, such as guidelines describing work standards. For illustration purposes we will concentrate in this paper on the interview data collected so far.

Narrative interviews. As indicated above, semi-structured interviews are conducted each month. The interview guideline was developed during the preparatory study and refined thereafter. The most important issues raised in the interviews are:

- Critical incidents (e.g. most positive/negative experience during the introduction in the last month)
- Learning strategies
- Handling of questions
- Handling of mistakes
- Subjectively perceived fostering/inhibiting factors
- Teaching strategies of others
- Expectations, special needs and
- Gained knowledge/lack of knowledge.

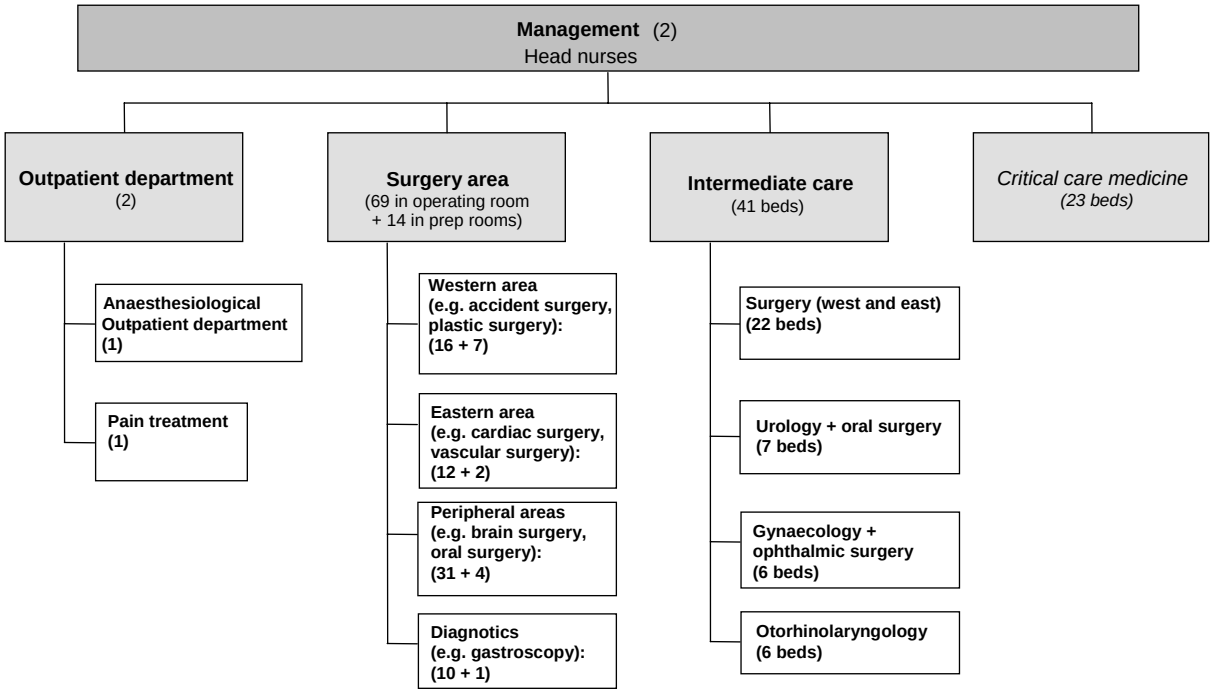
According to an ethnographic principle stemming from the grounded theory approach (Glaser & Strauss, 1967), questions are developed and refined during the research process (see also Schwartzman, 1993). E.g. as some individuals at the department pointed out their difficulties with the uncertain nature of knowledge at work partly caused by heterogeneous work conditions, we took a closer look at these issues by posing more pointed questions and involving persons entrusted with the development of work standards in the interviews. All interviews are tape-recorded, transcribed and interpreted according to qualitative content analysis.

With this methodology we hope to account for both theoretical shortcomings discussed in section 2.1. First, the research methodology pays attention to individual learning processes. Second, the processes of knowledge creation and learning are not abstracted form concrete learning contexts, but are seen in the interplay of learning strategies and situational factors, since the study stresses the pivotal role that heterogeneous working (and learning) conditions play in anaesthesiological care.

3.2 Tentative Results

As indicated above, the research process is still in progress. Therefore, we will present tentative results concerning the nurses' work and learning conditions and their interrelation with knowledge requirements and learning processes based on the narrative interviews conducted with novice as well as experienced nurses.

Heterogeneity and uncertainty in the work of nurse anaesthetists. One major source of heterogeneity and consequently of uncertainty in the department lies with the variety of workplaces nurse anaesthetists have to cover. Figure 1 shows all workplaces mastered by nurses at the department, which add up to 85 workplaces (83 in the surgery area, 2 in outpatient treatment) plus 41 beds to survey in 4 intermediate care areas.



(Note: Critical care medicine is not covered by nurse anaesthetists and thus not included in the study)

Figure 1. Nurses' workplaces at the department of anaesthesiology, university hospital of Innsbruck

In the interviews (translated by the authors), newcomers as well as oldtimers repetitively related uncertainty caused by this heterogeneity to issues of knowledge and learning, e.g.:

Quote 1: *„You cannot possibly know everything at the beginning, since there are so many areas, so many colleagues. Everyone does their work somehow differently. There are 120 anaesthetists, 70 or 75 nurses, you cannot suit everybody."* (experienced nurse)

Quote 2*: „Then he comes to the next workplace and there he will be told that this drug is very often used. And then, maybe after half a year, he will be working with me again and he will have forgotten what we use here. But by-and-by they [the newcomers] will get it, in the course of experience. That's what I tell them: time brings about experience and calmness, as opposed to routines."* (experienced nurse)

What is striking, though, is that much more than the different surroundings or diverse procedures due to different kinds of surgeries, the interviewees stress the uncertainty caused by the multitude of persons they have to work with, as is expressed in the following statement:

Quote 3: *„At the moment, I would know the ropes and get along fine at this workplace, but now, I have to rotate/switch again. Then, everything will be new again. That's awkward/unpleasant/nasty, also because of the new people. As for the names, that's very hard for me. I don't know them [colleagues at the next workplace] yet and in the operating room, everybody looks the same."* (novice nurse, second month)

In this respect, faced with a multitude of possibilities in anaesthesiology and with a multitude of different colleagues, the experience, that those people feature to a high degree different

preferences was outlined as a disturbing and unsettling factor by nearly all of the interviewees, notably by the newcomers, e.g.:

Quote 4: *„It's depending on who is the anaesthetist on duty, because one lets you do something, which another doesn't. For example today, he tells me: Draw this off, do this and do that! Then I think to myself: yes, okay. But on the next day, together with a different anaesthetist, you think: yes, now I could do this and then he doesn't like it, because he wants to do it himself."* (novice nurse, in the 1st month)

Quote 5: *„Certainly, it was difficult in the beginning, because one person tells you to fix the endotracheal tube this way, another tells you to do it that way. That was confusing in the beginning. Depending on different persons I had to prepare different things for the same kind of surgery. But my colleagues have always added that it is the final result that counts and that has to be all right. The patient has to be provided with what s/he needs and for yourself ... simply ... economical and, how shall I put it, straightforward working."* (experienced nurse)

The second major source of uncertainty, according to the interviews, is likewise constituted by human beings. Additionally to different preferences and work styles of diverse colleagues, the unpredictability of *patients* as prominent co-producers in medical treatment account for uncertainty at the nurses' work. Quote 6 and 7 may serve as illustrative examples in this respect.

Quote 6: *„The [oxygen] saturation level should not fall beneath a certain value, and it was significantly below that ... the patient has turned blue already. And then, you ask yourself if you made any mistake or if someone else made any. But that was'nt the case, because the tracheal/artificial respiration was working well, the endotracheal tube was correctly placed, thus ... it was simply due/up to the patient."* (novice nurse, 1st month)

Quote 7: *„You can say that there are certain basic standards in anaesthesiology, but due to the fact that every patient, every human being is individual, you never know what will approach you."* (experienced nurse)

The nurses thus draw an image of uncertainty at their work caused by heterogeneity of workplaces (surroundings, procedures, routines and people) and unpredictability of significant others' (colleagues or patients) behaviour. This heterogeneity in working conditions presents a challenge for memorizing learned practices. The variety of workplaces and the frequent rotation makes it difficult for nurses to establish consistent and durable object-level knowledge. Furthermore, too strong reliance on built knowledge and expectations is even regarded as potentially harmful in high reliability organizations. As discussed in the section above, metaknowledge thus may play an important role.

The role of meta-knowledge in the nurses' work. As for the empirical material analysed so far, we found a high prevalence of metaknowledge, notably at the level of experienced nurses, but also already in very early stages of the introductory period of novices. The examples beneath shall give an impression of the interrelation of uncertainty and metaknowledge materialized in nurses' narration about their everyday practice.

Due to the experience that their expectations are not always met, novices acquire the knowledge (declarative metaknowledge) that they cannot rely on their existing knowledge and that they need to mindfully date it up. In quote 8 additionally procedural metaknowledge

is mentioned, since the nurse explains his method of updating, thus has acquired knowledge about an updating strategy:

Quote 8: *"First, I've prepared everything and then I come back and the surgical assistant tells me: 'You know that everything has been changed again [the surgical scheme], don't you?' That means that I've prepared for the wrong surgery, because I relied too much on the plan from the morning. First, it was a standard preparation and then I needed to prepare for a more complex surgery, I needed an ‚artery' [more complex kind of monitoring] and the like. The problem is that you run the risk of a delay. Maybe the patient has already arrived or the anaesthetist or the surgeons are waiting … and then they say that this delay is my fault. Now I know that I need to check the surgical plan regularly for any changes in the computer. Now I do it early enough, then you know it. You just need to be up-to-date, you need to get the latest information."* (novice, 1st month)

Faced with problems and/or being aware of their imperfect knowledge, novices are encouraged to ask for help. To do so, they need to know whom to ask (declarative metaknowledge about other people's knowledge/competence). This can be difficult, since they need to do it early enough, not regarding it as a sign of weakness (quote 9) and since they are very early working alone in one operating room, next to constantly changing colleagues (quote 10):

Quote 9: *„There are certain emergencies, in which three nurses are needed. Therefore, concerning our young colleagues, I'm really making efforts to ‚beat into their heads' that they need to signal immediately if they are not able to manage the situation alone any more, because it is not a sign of weakness, it is just, six hands can do more than two. And mostly, at once there are also more anaesthetists ‚on stage', because they've called for help as well, and then three anaesthetists are crying, ordering things. And you think, they are all equally urgent, where do you start then? You cannot possibly manage that alone." (experienced nurse)*

Quote 10: *"If I have a problem, I ask for help. Margret [head nurse] told me that I could and should always ask. I can't ask other than nurse anaesthetists. I mean, the surgical assistants cannot help me and in certain circumstances, neither do the anaesthetists. They can't tell me, where I can find certain things, for example ... And the problem is, because of the clothing it is very hard to know who is who. I try to get to know those belonging to anaesthesiological care first, but it's hard ... everybody looks the same [due to the standard clothes, mask, hood/cap], it could be also a technician fixing something in the surgical area ..."* (novice, 1st month)

Also, experienced nurses are aware of the importance of this kind of declarative metaknowledge. They regard it as necessary to possess knowledge about other people's knowledge especially in case of emergency (quote 11) and they also stress the importance of other people's metaknowledge about their own knowledge for effective cooperation (quote 12).

Quote 11: *„Once I was called to the emergency room and the doctor just didn't turn up. Certainly, there was an emergency physician present … but then I simply called to the next floor and told an anaesthetist to come, who was'nt responsible for the emergency room at this time. No one will deny to come in such a situation, you just need to know whom to call and not to wait too long, if you realize you can't manage this alone any more."* (experienced nurse)

Quote 12: *„Then I told him that according to me, at the beginning he doesn't need to know how many milligrams per millilitre and so on. It's more important to tell the anaesthetist that he is a newcomer, because then, they will treat him certainly differently and they will tell him also millilitres and stuff. Thereby he will learn it automatically. But it's important to tell the anaesthetist for how long he is working here, then he will get help more easily."* (experienced nurse)

As already stated above, nurses stressed not only the relevance of knowing about own and others' knowledge, but also about others' preferences. Awareness of other people's, notably anaesthetists', preferences is related to metaknowledge in so far as this awareness has an impact on the reliance on one's own routines, expectations, knowledge and learning strategies:

Quote 13: *„Now, I will move again to another workplace, where the same will be done slightly differently. That's what they [colleagues] told me as well ... that another person ... everyone is different, one wants that you place it this way, the other one that way. And you need to find a medium, you need to find out what you want. I need to get to know all kinds of possibilities presented by diverse colleagues. Then, I can choose what suits me best. And there is a huge range of possibilities. At this workplace, I've just seen one aspect. Now I will discover other ones."* (novice, at the beginning of the 2nd month)

Variety and heterogeneity not only make learning difficult for novices, but also present a challenge for teaching. Experienced nurses have to cope with the introduction of novices in addition to their 'normal' work. They need to let the newcomers 'peripherally participate', as Lave and Wenger (1991) would call it, not overloading them with information and assigning tasks to them which they are able to manage. That requires metaknowledge about novices' previous knowledge and experience, as is expressed in quote 14, which also gives a hint as to the interactive processes involved in metaknowledge acquisition:

Quote 14: *„Due to the fact that we get so many different people to introduce: those engaged in the specific training [nurses with practical experience from usually smaller hospitals who attend a theoretical course in Innsbruck, accompanied by practical training at the department], critical care nurses, trainees from the nurses' basic training, new colleagues with no experience at all or colleagues with already some experience ... that was difficult for me at the beginning, you know, sometimes you've got two people, one pupil, who is absolutely 'fresh-water', and then one from the specific training, who maybe has already worked for five years somewhere in anaesthesiology. Then, it often happened that I told too much to one, or too less to the other. And afterwards I thought: no, he's working at the critical care unit, he will know this already, or: the other guy, he is an absolute beginner, he doesn't know this. That was the handicap for me in the beginning ... now, I continuously ask them: you were working there? How long did you work there? I somehow ask in a roundabout way: how are you doing anaesthesia over there? Or: what kind of surgeries do you have there? And then, after some time, I watch them, how they prepare and then I approximately can see what their handling is like. Certainly, you can't let a trainee work alone. He will just follow me. But with the people from the specific training, who come from smaller hospitals, it's harder to assess, because they may be quite experienced, but don't know certain kinds of surgeries."* (experienced nurse)

The development of (meta-) knowledge in the introductory period of the nurses. *"Time brings about experience."* This statement of an experienced nurse matches very well with what is known about the generation of metaknowledge: It requires a significant amount of time, since it is most effectively generated through interaction and communication processes (e.g. Brauner, 2002, p.14). Even if metaknowledge is abstract in so far as it is applied across several situations, its *generation* occurs through concrete interactions. Our empirical material suggests, in accordance with Lave and Wenger's (1991) approach that learning (acquiring object as well as meta-level knowledge) is strongly practice-based and thus situated. Metaknowledge is fostered by the experience of 'situated variety'. Some of the statements above have already shown how the experience of unexpected events, inconsistent with a

person's expectations, triggered reflection upon own and other people's knowledge. Further examples, focusing on active, concrete experience as opposed to more abstract forms of learning (e.g. to study written standard procedures), are presented below:

Quote 15: *„Yesterday, I fixed the endotracheal tube as Ann did it the day before and Margret said, that it's okay ... but the anaesthetist said that this is bullshit and then I did it like she wanted to ... and today I watched Susan how she does it and that was again in a different way. Now I decided simply to ask: how do you want it?"* (novice, 2nd week)

Quote 16: *„In the emergency room, you certainly learn a lot, notably calmness, because you don't know what will happen there, but the experience at every workplace helps you, for example, at otorhinolaryngological or oral surgeries, there are often difficulties of intubation. You learn to handle this over there and you possibly need that at any other workplace ... it will not occur that often, but it can happen everywhere, with every patient, that s/he cannot be intubated. Therefore, you learn everywhere, also depending on the complexity of the surgery, on the person instructing you and on the experience of your colleagues.* (experienced nurse)

To elaborate more deeply on the interrelation of learning processes and diverse situational factors, which is only alluded to here in a rather generalized way, will be a major task in our further data analysis. Our aim at this point was mainly to illustrate the discussed interplay between knowledge and working conditions, more concretely, the interrelation of heterogeneity and uncertainty on the one hand and metaknowledge on the other.

4 Concluding remarks

Aiming at a more thorough understanding of individual knowledge and learning processes with regard to the social and organizational conditions at place, we have focused in this paper on heterogeneous and uncertain working conditions and their interrelation with knowledge and learning. In this respect we proposed the concept of metaknowledge (Brauner, 2002) as social psychological complement to Weick and Sutcliffe's (2001) notion of mindfulness. We illustrated our considerations by presenting empirical material about knowledge and learning of nurse anaesthetists confronted with high levels of heterogeneity and uncertainty at work. Tentative results showed, first, a high prevalence of novice as well as experienced nurses' metaknowledge and, second, that learning processes including acquisition of metaknowledge are strongly practice-based insofar as people learn to cope with such environments by experiencing situated variety which involves interaction and communication processes. Metaknowledge thus proves to be a useful concept for analyzing mindful behaviour in knowledge terms. A further step in this respect would be to differentiate between managerial and operational mindful behaviour. Further reflection upon mindfulness and metaknowledge could be refined by this differentiation, since the kinds of knowledge on which the performance of operational as opposed to managerial actions is based, may differ respectively (see e.g. Becker & Brauner, 2003).

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